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COVER PHOTOGRAPH:

Krakenes Lake from Mehuken Mountain, western Norway, in April 1995. Photograph by Hilary Birks (see article by Catherine Duigan in this issue).

EDITORIAL

In taking on the editorship of *Quaternary Newsletter*, I am acutely aware of the superb job done by James Scourse over the last four years. Under his editorship, the *Newsletter* has developed into a stimulating mix of short scientific papers, news, reports of QRA meetings and comment on topical issues. I know that QRA members await their issues eagerly and, judging by the amount of copy received, growing numbers are wishing to contribute. These are all good signs, and much is owed to James Scourse for handing on such a healthy legacy. I am sure that all members would want me to extend their thanks to James for his stirring efforts: he will be a 'hard act to follow'!

Without the *Newsletter* to edit, and with sabbatical leave in 1997, James will be concentrating on research. Part of his time will be spent working with Professor Hans Petter Sejrup at Bergen on Quaternary marine geology; namely shelf sea palaeoceanography with emphasis on the Holocene evolution of shelf sea fronts. James is also looking forward to becoming involved in the newly-established IGCP Project 396, *Continental Shelves in the Quaternary*.

In James' last *Newsletter* editorial, he refers to the "calm efficiency" of the printing and production team - Richard Jones at Gwasg Ffroncon and Val Siviter (both Bethesda), respectively. I can already vouch for their experience and calming influence!

In *QN*79, James was faced with an exceptionally large amount of copy. We would both like to pass on apologies to those with articles or items deferred, and would stress that the problem was one of production logistics and nothing to do with late submission of materials.

In compiling and editing *QN*80, I have already made many new acquaintances in the Quaternary 'community' and renewed contacts with many colleagues and friends: *QN* editorship promises to be a rewarding experience. At present, I am 'learning the ropes' of *QN* editorship and production. The present system of 'light refereeing' and 'speedy publication' will continue: I have no plans for radical change. *QN* is your 'mouthpiece', and what you submit for publication will shape its future. It can only be as good and useful as you make it, so please, lots of high quality contributions! Contributors please note the revised timescales for submission of copy on the inside of the front cover.

Stewart Campbell

THE ENVIRONMENTAL HISTORY OF A LATE-GLACIAL SITE AT KRÅKENES, WESTERN NORWAY, BASED ON CLADOCERAN MICROFOSSIL ASSEMBLAGES: PRELIMINARY RESULTS AND INTERPRETATION

Catherine Duigan

Introduction

The diversity and abundance of the remains of Cladocera (Crustacea) in lake sediments are very important in palaeoenvironmental reconstructions (Frey, 1986). Previous palaeolimnological studies have demonstrated their usefulness in reconstructing past environments and the responses of lake systems to changes in climate and catchment processes (*eg* Frey, 1962; Whiteside, 1970; Hann and Warner, 1987). Lakes can be divided into two major habitats for Cladocera - open water and the littoral regions. Within these regions characteristic cladoceran species respond to a wide range of environmental parameters such as water chemistry, substrate type and predation pressure.

In 1993, an international, multidisciplinary project group was formed to study physical and biological aspects of climatic and glacial changes of the late-glacial sediments at Kråkenes, western Norway (Birks *et al.*, 1996). Emphasis is being placed on the rapid environmental changes associated with the Younger Dryas event. Glacial geomorphology, sedimentology, palaeomagnetism, radiocarbon (AMS) dating, identification and dating of volcanic ash layers, and CO₂ reconstructions from stomatal density are being studied. Along with the Cladocera, a number of other biological indicator groups are being analyzed, including pollen and spores, mosses, plant macrofossils, diatoms, other algae, Bryozoa, Oribatid mites, Chironomidae, Coleoptera and Trichoptera.

Study Site

The lake at Kråkenes (Lat. 62°02' N; Long. 5°00' E) is on a peninsula of the Vågsøy Island on the coast of the Nordfjord area of western Norway. The lake lies at 38m asl, is approximately 530m long, has three basins with a present maximum depth of 12m, and originally was 0.07km² in area (Larsen and Longva, 1979) (see cover photo.). At c. 100m asl on the side of the adjacent Mehuken Mountain lies the base of a cirque which contained a glacier during the Younger Dryas (Larsen *et al.*, 1984). Drainage from the glacier entered the

south-west lake basin and deposited a laminated sequence of sediments. A more detailed site description can be found in Birks *et al.* (1996).

Aspects of the palaeoenvironmental history of this site have been previously studied (Larsen and Longva, 1979; Mangerud *et al.*, 1979; Larsen and Mangerud, 1981; Longva *et al.*, 1983; Larsen *et al.*, 1984; Mangerud, 1987). There was no ice in the Allerød period and silty organic deposits with abundant animal and plant remains accumulated in the lake basin. During the Younger Dryas, laminated silts and more coarse-grained sediments, originating as glacial outwash and debris flows, were deposited. The mid-Younger Dryas Vedde tephra is clearly discernible in the sediments. With the advent of the early Holocene, silt input decreased quickly and organic sediments were deposited.

Analytical Methods for Cladocera

Samples from 27 levels were prepared after Frey (1986). The material was treated with KOH and HCL. The final preparation was stored in glycerol and temporary mounts were made for the purpose of identification and counting. Counting was carried out until 150-200 quantifiable remains were identified, except where remains were very rare (685cm, 763cm, 769cm, 791cm, 823cm, 827cm, 832cm, 882cm, 920cm, 968cm) and then 8-10 slides were systematically scanned.

Results and Interpretation

A total of 18 Cladoceran taxa were identified from the material examined. The chitinous remains included ephippia, headshields and shells. A maximum of 14 taxa was recorded from a single sample in the Holocene. No cladoceran remains were found in two samples from the Younger Dryas sediments (at 769cm and 827cm). It is evident that taxon diversity varied considerably throughout the sequence.

The littoral component is mainly represented by chydorid species such as *Alonopsis elongata* and *Chydorus piger*. The characteristic open-water taxa are represented by the non-chydorids *Bosmina* and *Daphnia*. With the exception of samples from mid-Younger Dryas sediments, *Bosmina* was the most frequently encountered remains. *Chydorus sphaericus*, *Acroperus harpae*, *Alonopsis elongata*, *Alona affinis*, *Alonellana*, *Chydorus piger* and *Bosmina* sp. occurred most frequently throughout the sequence.

There is a distinct oligotrophic character to the cladoceran assemblage reported from Kråkenes. Species such as *Camptocercus rectirostris* and *Alonopsis elongata* are considered characteristic of nutrient-poor environments. The composition of even the most diverse assemblages is consistent with communities described from oligotrophic waters with low pH (Duigan and Kovach, 1991;

Fryer, 1993). *Chydorus sphaericus*, *Acroperus harpae* and *Alona affinis* are known to occur over a wide range of conditions and they are tolerant of environmental stress (Duigan and Kovach, 1991; Duigan, 1992). Therefore it is not surprising that they persisted throughout the study period. The major stratigraphic periods correspond to changes in cladoceran taxa composition and abundance that are supported by the constrained cluster analysis of the data (Figure 1):

Deglaciation: The lake sediments began to accumulate soon after deglaciation of the area at approximately 12,300 BP (Mangerud *et al.*, 1979; Larsen *et al.*, 1984). The lowest discernible limnic sediment was found at 970cm and a single *Chydorus piger* shell was the only identifiable cladoceran remain at 968cm. Little can be reliably inferred on the basis of this single record. However, its presence is consistent with modern high frequencies of occurrence on bare substrates such as peat, mud, sand and rock (Duigan, 1992; Fryer, 1993). *Daphnia* and *Bosmina* remains are noticeably absent and this corresponds with no planktonic diatoms being recorded immediately after deglaciation (Jones, pers. comm.). Evidence from other floral and faunal groups suggest that oligotrophic but quite alkaline conditions prevailed.

Allerød: There was a rapid development of cladoceran fauna during this period, starting at around 11,485 BP (or between 953cm and 924.5cm). Cladocera occurred in both the littoral zone and open water. Conditions remained oligotrophic on the basis of the diatom assemblage (Jones and Battarbee, pers. comm.). This sudden increase in biodiversity is reflected in other plant and faunal analyses. The plant macrofossil and moss assemblage is considered analogous to low and mid-alpine zones in western Norwegian mountains today (Jonsgard and Birks, 1995). The chydorids were probably living mainly amongst *Nitella*, which was the dominant aquatic macrophyte (Birks, unpublished). *Chydorus sphaericus*, *Acroperus harpae*, *Alona affinis*, *Alonella nana* and *Alonopsis elongata* are considered "pioneer species" ie early immigrants after ice withdrawal (Nilssen and Sandøy, 1990).

Allerød - Younger Dryas transition: There is an abrupt lithostratigraphic boundary between the Allerød and Younger Dryas. Loss on ignition values decreased significantly and the sediment changed from a brown coarse detritus gyttja with silty bands to a grey unlaminated silt. It is therefore not surprising to have a dramatic change in faunal and floral community composition. The developing cladoceran community present in the preceding Allerød was abruptly reduced in terms of species diversity.

Younger Dryas: A cirque glacier formed quickly at Kråkenes at the start of this period, with a corresponding increase in snow and ice cover. Much of the land surface was very wet, with running water and unstable minerogenic soils, during the short, cool summers (Jonsgard and Birks, 1995). Substantial

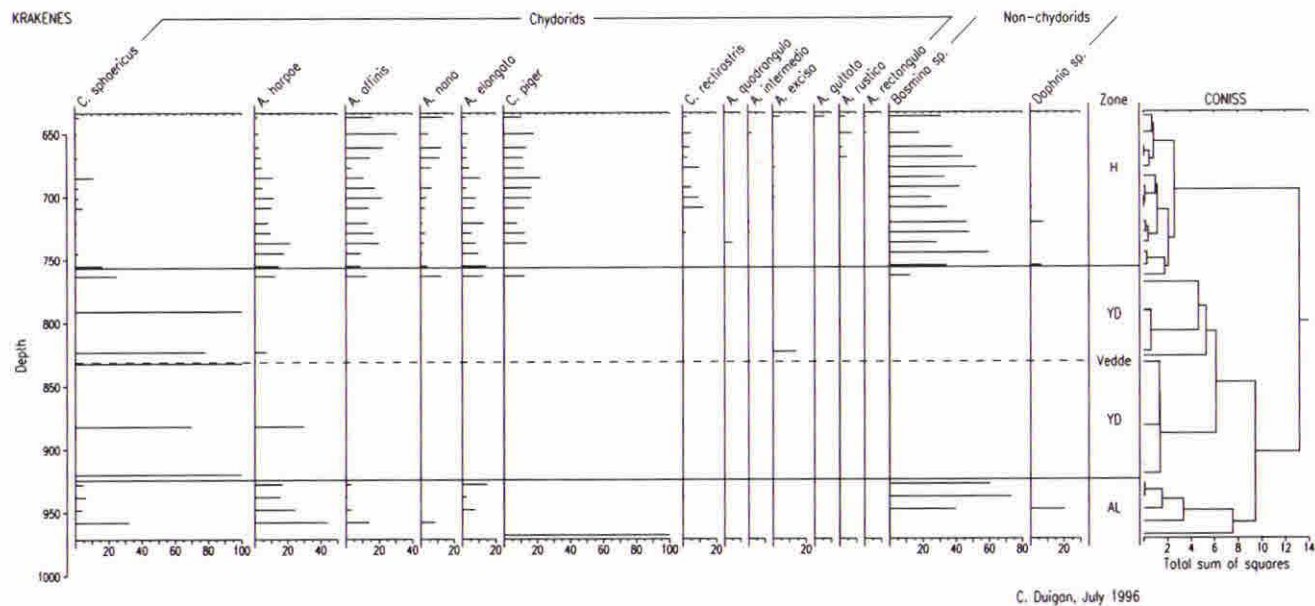


Figure 1. The relative abundance of the major cladoceran taxa from Kråkenes. The taxa are arranged approximately on the basis of their persistence and appearance throughout the study sequence. AL = Allerød; YD = Younger Dryas; H = Holocene.

amounts of eroded material were deposited in the lake basin. A decrease in water transparency has been shown to reduce cladoceran abundance and species diversity (Tsukada, 1972). Together with temperature, it is likely that turbidity was one of the major environmental influences in Kråkenes lake during this time.

Chydorus sphaericus and *Acroperus harpae* are the only species of Cladocera which persist in significant numbers throughout this period. The reduced diversity of the chydorids during this period is consistent with reports from other areas (eg Germany: Hofmann, 1986; England: Goulden, 1964; Denmark: Whiteside, 1970). These have been attributed to the climatic conditions of the period.

It is interesting to note that few or no diatoms were reported between c. 912cm and 839cm. Two alternative scenarios have been proposed to account for this phenomenon; i) conditions were unsuitable for diatom preservation or ii) few diatoms were produced (Jones and Battarbee, pers. comm.). The latter case is considered most likely as the diatom disappearance would suggest deteriorating growing conditions, such as prolonged ice cover and/or extreme turbidity. There is no clearly discernible cladoceran response to the deposition of the Vedde Ash, although, it may have improved growing or preservation conditions for the diatoms (Jones and Battarbee, pers. comm.).

Younger Dryas - Holocene transition: A recovery in cladoceran diversity is discernible in the uppermost section of the Younger Dryas sediments and it is probably indicative of climatic amelioration. Similar responses have also been found in the diatoms and other algae, and the appearance of warmth-tolerant chironomids. In terms of cladoceran species composition the early Holocene assemblage is similar to that recorded in the Allerød.

Holocene: At the end of the Younger Dryas, the cirque glacier melted rapidly and the lake was quickly colonised by mainly tufted plants characteristic of stony shores eg *Isoetes* sp. and *Subularia aquatica* (Birks, unpublished). *Sphagnum* becomes a common component of the bryophyte assemblage during this period, coinciding with the disappearance of *Fontinalis antipyretica*, a reduction in the representation of all aquatic plants and a change in the diatom flora suggesting that a gradual acidification of the lake system accrued. Plant growth form also became more diverse with the occurrence of more floating and submerged broadleaves eg *Potamogeton*, *Nymphaea* (Birks, unpublished).

In general, the relative high chydorid diversity and abundance of the Holocene sediments corresponds to a rich and diverse macrophyte assemblage in the lake. Changes within the period probably partly represent the vegetational succession described above. The universal species (*Chydorus sphaericus*, *Acroperus harpae*, *Alona affinis*) are being replaced by taxa with more specific requirements.

In particular, there is an increase in the number of taxa associated with bryophytes and specific acid/oligotrophic conditions *eg Alonella nana, Alonella excisa* and *Alona rustica*.

Observations on the modern ecology of *Alona* in Norway support the acidification interpretation of the profile. *A. affinis* is a common species, and it seems to be indifferent to pH (Walseng, 1994). In contrast, *A. quadrangularis* is not found below pH 5.0, while *A. guttata* and especially *A. rustica* are most common at pH < 5 (Walseng, 1994). However, because of the multi-causal nature of acidification, it is likely that pH is not the only environmental influence (Nilssen and Sandøy, 1990). Changes in habitat structure (*eg* plant growth forms) and substrate types are likely to play significant roles. It is hoped that the multidisciplinary approach of this project will allow the definition of the extent and relative influences of the various environmental parameters and biotic responses.

To conclude, the results reported here provide a further demonstration of the value of Cladocera as palaeoenvironmental indicators. They generally support the hypothesis that increases in cladoceran biodiversity and abundance are linked with climatic improvements and the associated environmental changes and *vice versa*.

Several options for the further development of this research are being considered. A small number of additional samples are available for analysis. There will be future opportunities to compare the Cladocera to the responses of other organisms, as the results of the analyses of the other plant and animal bio-indicators become available. A potential opportunity to carry out quantitative reconstructions of water temperature based on the Cladocera data awaits further exploration.

Acknowledgements

This report serves as an extended abstract for a presentation given at the 4th International Symposium on Cladocera, Postojna (Slovenia), August 8-15th, 1996. Attendance at this meeting was made possible by financial support from the British Council and the Countryside Council for Wales. I am grateful to Hilary H. Birks, the Kråkenes Research Project Co-ordinator, for the opportunity to participate in this research and for her constructive comments on this report. Sylvia Peglar and Chris Birks prepared the sediments. V.J. Jones and R.W. Battarbee provided access to unpublished diatom data and interpretations, and comments on this report. Warren Kovach assisted with the production of Figure 1. This paper is Kråkenes Project Contribution no. 12.

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AN ANGLIAN TILL AT LONG HANBOROUGH, OXFORDSHIRE?

J. Coe

Introduction

Previous research in the Midlands and Upper Thames Valley has placed the southern extent of Pleistocene glaciations in the Bledington to Moreton-in-Marsh area (*cf* Bishop, 1958; Sumbler, 1983, 1995; Bowen *et al.*, 1986; Bridgland, 1994). As illustrated in Figure 1, this limit is at least 7km north of the village of Long Hanborough, Oxfordshire. However, the discovery of a possible till at St George's Well (SP 418146; c. 90m OD), Long Hanborough, may require a reappraisal of the limits and complexity of ice advance associated with the Anglian Stage.

The deposit is exposed within an area variously defined as 'head' or 'brickearth' (Arkell, 1947; BGS Witney Sheet 236) and, altitudinally, lies between the levels of the Hanborough and Wolvercote Members¹ of the Upper Thames Formation. Sedimentological analyses suggest that it comprises a diamicton and superimposed, thin veneer of limestone gravel. The latter appears to represent solifluction from the nearby Hanborough Member. Deposition between the aggradation of the Hanborough and Wolvercote Members may have been *via* an ice tongue following the route of a contemporary dry valley between Crawley (SP 3311) and Long Hanborough. However, alternative explanations evoke ice rafting of material from the Moreton Drift, or glacial deposition prior to the aggradation of the Hanborough Member.

Analysis

The St George's Well diamicton is exposed for a width of approximately 5m and rises 0.5m from the floor of a new car park which has been excavated from the side of a hill. Whilst its appearance is rapidly deteriorating, it is clearly matrix-supported and contains many clasts of gravel, pebble and cobble grade which show no preferred orientation. Lithologically, the clasts are dominated by quartz and quartzite, with lesser proportions of flint, coal, volcanics, and subangular/angular limestone fragments. Many of the clasts are broken, even those of most durable lithology. In an attempt to replicate such breakages, a representative sample of clasts was placed in an environmental simulation cabinet under arctic conditions (with 65 diurnal fluctuations between -5 and (+)13°C) and displayed no signs of disintegration. Point-load tests show that forces of 4.1-13.2kN (dependent upon lithology and individual rock weaknesses) are needed to fracture the stones.

Laboratory analyses indicate that the yellowish-brown (10YR 5/4) diamicton is a poorly- sorted mix of 22.96% sand, 66.77% silt and 10.33% clay, and contains 11.99% calcium carbonate. It acquires 95.64% of its saturated

¹ The stratigraphic nomenclature followed is that revised by Bowen *et al.* (in press).

isothermal remanence (SIRM) in an applied field of 200mT, is saturated at 500mT, and rapidly loses its magnetism within a reversed field. Such a pattern of magnetic remanence is indicative of sediment dominated by ferrimagnetic minerals, principally magnetite and maghemite (Thompson and Oldfield, 1986).

Scanning electron microscopy of the diamicton reveals quartz grains which vary greatly in angularity and relief. Quantification of the results shows that grain shape reflects the relative effects of conchoidal fracturing, breakage blocks, cleavage planes, impact pits, and complete grain breaks. Superimposed upon these features, and affecting 5-15% of the grains, are a number of scratches and steps. The individual features and variety inherent within the textural assemblage imply a high-energy, glacial cycle of erosion (Krinsley and Funnell, 1965; Krinsley and Margolis, 1969; Margolis and Krinsley, 1974; Whalley and Krinsley, 1974). A glacial component is further supported by chattermarks on 5% of the grains, a feature which has been attributed to glacial grinding, chemical decay and diagenesis (Marshall *et al.*, 1987). There is also a notable absence of characteristically aeolian or fluvial features, including 'V'-shaped impact pits, upturned plates, hertzian fractures, and rounded, low relief grains (Lindé, 1987; Mazzullo and Anderson, 1987; Bull and Magee, 1988).

In sharp contrast to the diamicton is a superimposed layer of relatively well-cemented limestone gravel, which varies in thickness from 5-20cm. Its yellowish-brown (10YR 6/4), poorly-sorted matrix is composed of 81.11% sand, 16.09% silt and 2.80% clay, and has a calcium carbonate content of 83.74%. It comprises 9.72% ferrimagnets and 0.12% canted antiferromagnets and, with respect to the diamicton, is richer in magnetic grains within the stable single domain/superparamagnetic size fraction. The suite of quartz grain surface features in the limestone gravel is dominated by subangular and angular grains of medium relief, with oriented etches, steps, conchoidal and cleavage fractures. A medium-energy environment of transport and deposition is implied by grain shape and texture. The lack of striae, broken grains, hertzian fractures, and upturned plates precludes a direct glacial or aeolian input and thus a fluvial interpretation is favoured (Margolis and Krinsley, 1974; Lindholm, 1987; Trewin, 1988).

Interpretation

The diamicton at St George's Well does not appear to have been derived from the superficial deposits which surround the Long Hanborough area. Whilst its location might suggest solifluction of the Hanborough Member or Northern Drift Formation, the alignment of clasts within solifluction deposits is frequently sympathetic with the local topography or vertical, if affected by freeze-thaw cycles (Lowe and Walker, 1984; Ballantyne and Harris, 1994;). The diamicton shows no such orientation. It is also likely that its broken clasts reflect glacial grinding and loading/unloading, or high impact collisions against immovable objects in fast-moving or turbulent water rather than post-depositional frost shattering.

The diamicton fails to share many sedimentological properties with the local drifts. For example, whilst its lithological assemblage is common to many of the Pleistocene deposits of the area, there is a complete absence of coal in the higher Northern Drift or Hanborough Member. Whilst coal is frost-sensitive and non-durable in gravel-bed rivers, the author's examination of deep and numerous sections of the Northern Drift and Hanborough Member strongly suggests that it has never existed in these deposits. Instead, the introduction of coal to the region appears to be associated with the deposition of the Wolston Formation of the Midlands (*cf* Sumbler, 1995). Furthermore, unlike the diamicton, the Northern Drift Formation lacks calcium carbonate (Hey, 1986; Bridgland, 1994) and, as observed by the author and Bull and Goudie (1987), is typically composed of sand grains with a glaciofluvial signature. Extensive decalcification of the Hanborough Member is unlikely; the quartz grain surface textures of the latter are fluvial whilst those of the diamicton are glacial.

The mineral magnetic signal also separates the diamicton from the local superficial deposits. The Hanborough Member (SP 418145; 95m OD) is characterised by a significant proportion of frequency-dependent and superparamagnetic grains, and comprises 1-6% ferrimagnetic and 11-33% canted antiferromagnetic minerals. With its susceptibility (χ) generally greater than $2.0 \times 10^{-8} \text{ m}^3 \text{ kg}^{-1}$, the Northern Drift Formation (following the analysis of 77 samples), contains a much lower concentration of magnetic minerals than the diamicton at St George's Well in which $\chi = 13.71 \times 10^{-8} \text{ m}^3 \text{ kg}^{-1}$.

The veneer of limestone gravel capping the diamicton at St George's Well is derived *via* solifluction from the Hanborough Member. Their sand:silt:clay ratios and calcium carbonate contents are almost identical, the Hanborough Member displaying mean values of 74.95% sand, 22.33% silt and 2.72% clay, and 81.58% CaCO_3 at Long Hanborough (SP 418145; 95m OD). However, the gravel at St George's Well is much less well-sorted, highlighting its disturbance subsequent to its initial deposition in the area. The morphology of the quartz grains at both sites is also similar, as is the intensity and extent of chemical decay of the grains (Coe, unpublished data).

Regional context

Prior to any consideration of the implications of a glacial deposit within the Upper Thames Formation, the limited and isolated nature of the field exposure of the 'till' should be re-emphasised. Whilst laboratory analyses of the diamicton support a glacial interpretation, no larger-scale features characteristic of glacial deposition (including glaciodynamic structures and high consolidation) are apparent. Diamicton may also be spatially variable in composition, even over a relatively small area. The following discussion is, therefore, a reconstruction of the events which might have occurred if Middle Pleistocene glaciation extended into the Upper Thames. It is by no means intended to be unequivocal.

The diamicton at St George's Well lies between the levels of the Hanborough and Wolvercote Members of the Upper Thames Formation and does not appear to have been derived from the solifluction of either the Northern Drift Formation or the Hanborough Member. This presents the possibilities that it represents a glacial incursion at some stage between the deposition of (a) the Northern Drift and the Hanborough Member, (b) the Hanborough and Wolvercote Members, or (c) that it is not a 'direct' glacial deposit, but the result of ice-rafting from the Moreton Drift.

If the first scenario is accepted, the ice which deposited the diamicton may also have been responsible for the first significant erosion of the local Jurassic rocks in the Upper Thames Valley and thus helps to explain the dichotomy between the apparently carbonate-free Northern Drift Formation and the younger limestone gravels. The direction of ice advance would presumably have been from the Midlands, *via* the Evenlode Valley, and substantially deepened the upper and middle courses of the Evenlode. This glacial episode may have been more intimately associated with the deposition of the Northern Drift Formation than that of the second scenario outlined below, although the disparities between the lithology and composition of the diamicton and both the Northern Drift and Hanborough Member cannot be accounted for by this interpretation.

An alternative sequence of events requires that the diamicton is intermediate in age between the Hanborough and Wolvercote Members. In this scenario, the ice must have taken a different route since the Hanborough Member is preserved in a number of dissected patches in the Evenlode Valley between the Vale of Moreton and Long Hanborough and is unlikely to have survived glacial erosion. It is possible that ice penetrated somewhat to the south of the present middle/lower Evenlode Valley and followed the course of what is now a deep, dry valley between Crawley and Long Hanborough (Figure 1). This forges a link between the Midlands and Upper Thames which can only be substantiated by more detailed comparisons between the diamicton at St George's Well and the Wolston Formation. Observations by the author suggest that lithologically and sedimentologically, the diamicton is more similar to the drifts of the Midlands than the Upper Thames. This is substantiated by a proposed link between the Paxford/Ditchford Gravels in the catchment of the River Stour and the Hanborough Member of the Evenlode, based on compositional and stratigraphical evidence, and consequent interpretation of the Wolston Formation and glaciation of the Cotswolds as post-dating the diversion of the River Thames from the Vale of St Albans by Anglian ice (Coe, in prep.).

The Hanborough Member is believed to be the upstream equivalent of the Boyn Hill Member of the Middle Thames Formation (Gibbard, 1985). This Member post-dates the diversion of the Thames from the Vale of St Albans, an event associated with the Anglian Stage, and thus, in this second scenario, the St George's Well diamicton must also be post-Anglian. This raises the possibilities of post-Oxygen Isotope Stage 11 glaciation or, more likely, a compound Anglian Stage as advocated by Bridgland (1994) and Sumbler (1995).

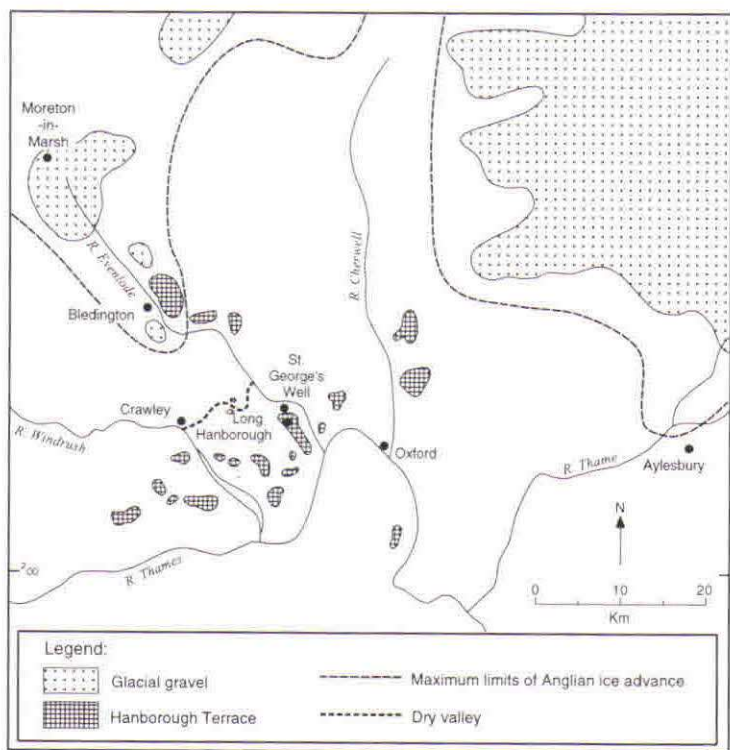


Figure 1. The Upper Thames Valley showing the limits of Anglian glaciation and the location of sites mentioned in the text.

A third explanation, which does not negate the glacial interpretation of the diamicton at St George's Well but accounts for a lack of glacial outwash in the immediate vicinity, invokes ice-rafting of glacial sediment from the Moreton Drift of the Midlands. This interpretation does not entail an extension of the limits of ice advance, but implies the grounding of ice rather than its gradual decay, since there is no evidence of water-sorting or clast orientation within the diamicton. However, it is debatable whether the frequently gorge-like nature of the Evenlode Valley could have permitted significant ice-rafting (and the true extent of the diamicton is impossible to determine).

This paper notifies those familiar with the superficial deposits of the Midlands and the Upper Thames of the existence and nature of a hitherto unidentified diamicton at Long Hanborough, without intruding too greatly upon the complicated stratigraphy of the area. The author would welcome any comments, since this analysis contributes to ongoing work for a D.Phil. thesis, entitled *A Palaeoenvironmental Reconstruction of the Northern Drift of the Evenlode Valley, Oxfordshire, England*.

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THE QUATERNARY RECORD OF KENT'S CAVERN - A BRIEF REMINDER AND UPDATE

Allan Straw

Introduction

In 1865, William Pengelly began the sixteen-year programme of excavation of Quaternary sediments in Kent's Cavern that was to yield results which revolutionised Victorian opinion concerning the evolution of early man, and which placed the Cavern firmly in the international class.

Last April, QRA members attending the Annual Field Meeting had the opportunity briefly to examine some of the deposits that had been identified and described by Pengelly, under the expert guidance of Dr C. Proctor (Proctor, 1996). Proctor is the most recent of researchers to refine the Cavern stratigraphy and the first to obtain a group of Uranium Series and Electron Spin Resonance dates on speleothem samples (Proctor, 1994). These, at last, provide a basic chronology for some of the major events responsible for the sequence of sediments and for the pre-excavation appearance of the cave. Time was not available on the Field Meeting to discuss these events, and this note is intended to provide a broader appraisal.

Early excavations

Pengelly's excavations had been preceded by some conducted by members of the Torquay Natural History Society (including himself) in 1846 and by those of Father John MacEnery (1825-1829) who withheld publication of his findings in deference to the opinions of William Buckland. MacEnery's manuscript notes were however posthumously published in part (Vivian, 1859), but his work was conducted haphazardly, excavation spoil was carelessly disposed of, and he failed to understand the true stratigraphy of the deposits. Pengelly proceeded in a highly professional manner, using an innovative and, for its time, exact method of digging and recording developed earlier in work at Brixham (Pengelly, 1874). He kept daily logs of the excavations (now lodged in six volumes in the care of the Torquay Natural History Society [TNHS] in Torquay Museum), and published annual summaries of the progress of digging and of the geological and archaeological discoveries in *Reports of the British Association* (1865-1880). These reports he had re-published in 1884 in the *Reports and Transactions of the Devonshire Association (RTDA)* as Part V of a comprehensive review of all the researches and publications concerning Kent's Cavern up to 1880. Part II of this review includes, for instance, a full reprint of MacEnery's manuscript (Pengelly, 1869).

Such was the climate of opinion at the time and such was the controversial nature of Pengelly's discoveries that he had continually to reiterate, elaborate

and defend his interpretations, and this he did with patience, courtesy and good humour within a long series of 'Notes on Recent Notices of the Geology and Palaeontology of Devonshire' in the *RTDA*, particularly in 1875, 1876, 1880 and 1881. Pengelly's diaries, reports and notes still make fascinating reading for the Quaternary scientist, and further insights into his character, scientific integrity and intercourse with eminent personages, many of whom were visitors to the Cavern, can be obtained from the Memoir on his life published by his daughter Hester Pengelly in 1897.

Since 1880 formal excavations in Kent's Cavern have been conducted by A.H. Ogilvie and some other members of the TNHS (1926 - 1940). Brief accounts of the work were published in *Reports of the British Association* from 1927 to 1938, and in the *Transactions and Papers of the Torquay Natural History Society* (Benyon *et al.*, 1929; Smith, 1940). The results, however, were largely insignificant with the work being relatively poorly executed and documented. By contrast, the geology of the Kent's Cavern area was carefully mapped and described by Vachell (1953) in the first serious attempt since Pengelly's work to provide a comprehensive discussion of the setting, origin, sediments and archaeology of the Cavern. This was followed in 1971 by a review, based on Pengelly's notes of the Quaternary sediments and their contained fossils and artefacts, by Campbell and Sampson (1971) who, for the first time, constructed illustrations of sections of the deposits. Pengelly's stratigraphy was endorsed, the main sedimentary units being as follows:

Black Mould	('Soil' - silt, organic and cultural debris)
Granular Stalagmite	(Speleothem)
Cave Earth	(Debris flow)
Crystalline Stalagmite	(Speleothem)
Breccia	(Debris flow)

In 1983 Straw outlined the geomorphological and sedimentary features of the Cavern and offered a sequence of events, stressing the fact that the inner and outer parts of the Cavern differ in several important respects. In 1988 the management of Kent's Cavern Ltd encouraged and sponsored several new studies of the cave's geology, geomorphology and archaeology, including a re-survey by Proctor and Smart (1989) and speleothem dating by Proctor (1994).

The Original Appearance of the Cave

The greatest human impact on the cave has therefore been Pengelly's, and it is important for any serious visitor to appreciate the nature and scale of his excavations and, by so doing, gain an impression of the cave's still largely natural appearance when excavation began in 1865 and progressed through the Cavern.

At that time the Ilsham Valley, in the west flank of which Kent's Cavern lies, was well removed from the urban developments of Torquay, being accessible

only by a rough track. It was wooded and its sides were strewn with limestone boulders and talus. Of the two available entrances the southerly one, an arch 2m high and 3m wide at the base had been deliberately blocked. The northern entrance, as today, led into the Vestibule (Figure 1) which had been dug into by MacEnery and others. As a consequence, Pengelly began his excavations in the Great Chamber, his first objective being to remove sediment throughout the Cavern to a depth of 4 feet (1.22m) below the bases of capping speleothems, which were generally 1 to 2 feet (0.30-0.61m thick) but in places over 5 feet (1.53m) and exceptionally 12 feet (3.66m) thick. This he achieved by 1880, removing all debris out of the Cavern, but the intention to dig out a second 4-foot layer was abandoned. The last seven months were however spent deepening the Long Arcade by another 5 feet (1.53m).

The Great Chamber (Figure 1) had an air space some 4m high but its floor was highly irregular and covered mostly by limestone blocks, some over 3m across and estimated at 7 tons or more, cemented into a thick speleothem, the Granular Stalagmite. The Lecture Hall and South West Chamber presented the same appearance, one boulder between the two standing 2m above the floor and weighing about 100 tons. Wall bosses up to 2m thick encroached onto the floor. These boulders and many of the bosses were broken up with gunpowder and removed from the Cavern. This rough character of the Cavern floor held through most of the system. The South West Chamber was closed off by a wall of speleothem and boulders, boulder piles clogged the Passage of Urns and the top of the Sloping Chamber, and massive boulders had to be dealt with in the Vestibule, Wolf's Cave, Long Arcade, Cave of Inscriptions, Labyrinth and Bears' Den. Huge floor bosses of stalagmite up to 3m high were removed, especially from the Labyrinth, Cave of Inscriptions and Bears' Den.

As the excavations proceeded several new passages were discovered and cleared - the Sally Ports and Smerdon's Passage (beneath the south entrance) in 1869 and 1870, the Water Gallery in 1869, Clinnick's Gallery, and Rocky Chamber in 1874-5 and 1879-80, the Labyrinth in 1876 and the High Level Chamber in 1875 and 1878-9. All had been blocked with sediment and speleothem and required arduous excavations in constricted situations. In the case of Clinnick's Gallery, what had appeared to be a small short recess became a sinuous passage some 23m long containing Breccia capped by over a meter of hard speleothem and an air space above of similar height. In the Labyrinth, massive roof penants and fallen blocks of limestone had been partly buried in Breccia and Crystalline Stalagmite to create a maze of passages most difficult to enter and negotiate. Eight months' work was needed to remove most of the blocks, several huge bosses of stalagmite standing up to 3.0m high, and a metre or so of Breccia. It should be remembered that work was by pick, shovel and wheelbarrow, in dirty, cold and often damp conditions, and by candlelight. Today the Cavern with electric light, a firm floor, and plenty of air space presents a remarkably tidy and uncluttered appearance, with easy access to

most of the major elements of the system. Only the Wolf's Cave, High Level Chamber, and Sally Ports apart from many small passages are unimproved and still allow some appreciation of the excavation conditions and the difficulties under which the workmen laboured.

By 1880 thousands of tons of sediments and rock (and micro-fossils) had been removed from the Cavern, plus some 50,000 fossils, artefacts and extraneous stones, so it is not surprising that the present floor is on average some 2m lower than originally.

Pengelly was of course aware at the outset of MacEnery's results and views on the stratigraphy, but within two years had realised that the succession was more complex. By 1868 he had found the Breccia and Crystalline Stalagmite *in situ*, recognised them as wholly older deposits than the Cave Earth and Granular Stalagmite, and identified a major phase of disruption between emplacement of the two series. By 1875 he suspected, and in 1878 proved, the existence of former entrances in the back of the cave. From the beginning he carefully recorded the diverse macro-faunas, artefacts and extraneous stones discovered in the deposits, and was able to demonstrate the great contrast between the Breccia, with its bear-dominated fauna and few Lower Palaeolithic artefacts, and the Cave Earth with its horse-hyaena-woolly rhinoceros fauna and rich Middle and Upper Palaeolithic artefact assemblage. He proved beyond doubt to a largely sceptical Victorian world that early man had indeed co-existed with extinct animals.

The Dichotomy of Kent's Cavern

Fundamental to understanding the sequence of events that controlled both emplacement and erosion of the Quaternary sediments is appreciation of the contrast between the inner and outer halves of the cave system (Straw, 1983). Some of the differences can be noticed on Figure 1 (reproduced by permission of the Executive Committee TNHS, from Straw, 1995). *In situ* Breccia (Figure 1) is confined mostly to the inner half having entered through now-blocked openings in the rear of the cave. The roof here exhibits fine phreatic features. The Breccia contains Lower Palaeolithic artefacts and a predominantly bear (*Ursus deningeri*) fauna (Bishop, 1996) and the Cave Earth is patchy and thin. The bulk of the Cave Earth (Figure 1), having passed through the present entrances, occupies the outer half where roof-fall has destroyed most original phreatic features and where the Granular Stalagmite is best developed. The Cave Earth contains eroded blocks of Crystalline Stalagmite (some unfossiliferous from where it has rested on limestone, others fossiliferous from capping the Breccia) and Breccia (Figure 1), Middle and Upper Palaeolithic artefacts and a very diverse mammal fauna (Garrod, 1926; Campbell and Sampson, 1971; Campbell, 1977).

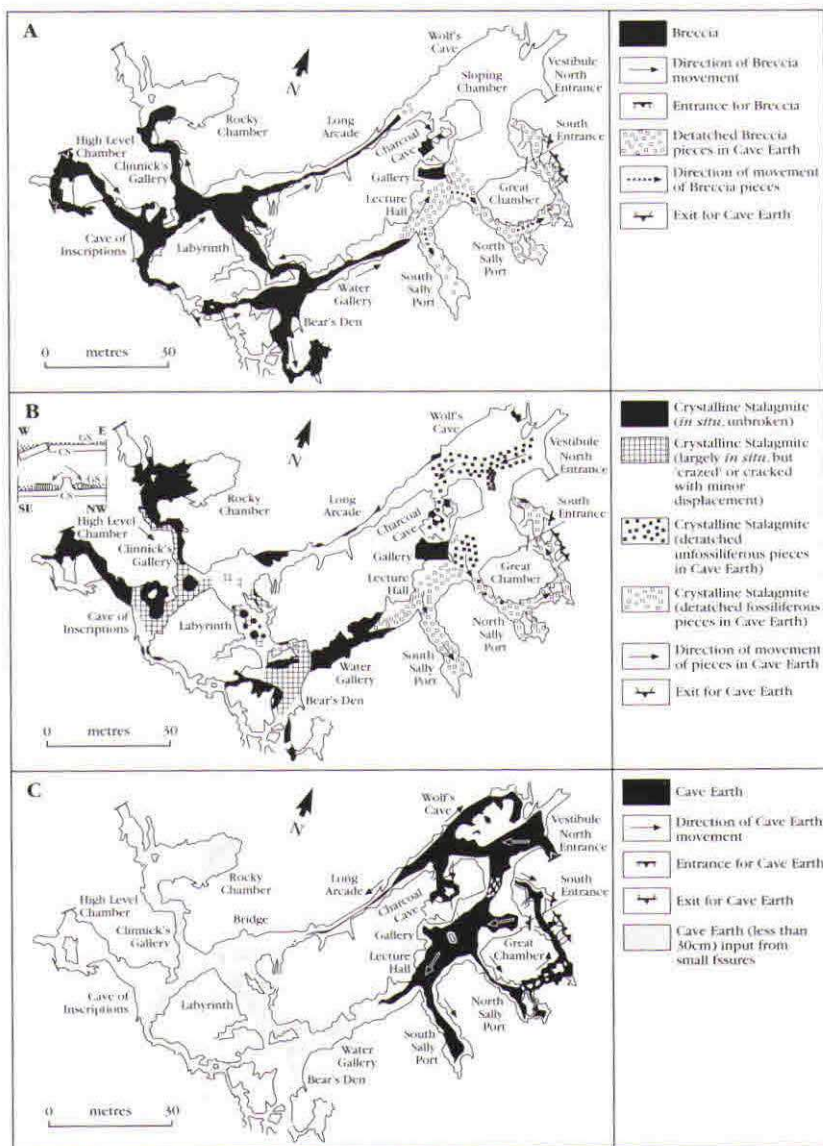


Figure 1 Kent's Cavern. Distribution of: A. Breccia; B. Crystalline Stalagmite; and C. Cave Earth. A-C are shown as indicated in Reports to the British Association by W. Pengelly, 1865-1880. Cave outline is based on the survey by Proctor and Smart (1989).

The **Crystalline Stalagmite** (Figure 1) seems originally to have occurred throughout the Cavern but survives in the outer half only as a component of the Cave Earth or as wall fragments. Pengelly encountered large areas of Crystalline Stalagmite in the inner half though in many places it was cracked and displaced. He had realised within a few years of commencing work that conditions in and around the Cavern in Cave Earth time were very different from those of Crystalline Stalagmite and Breccia times.

The Sequence of Events

The Cavern system was probably initiated in the Late Tertiary or Early Quaternary when the Devonian limestone outcrop and adjacent shales still had a Permian cover (Straw, 1995). It may have been pre-determined in part by palaeokarst features which are known from many localities around Torbay (Lloyd, 1933; Richter, 1966). Initiated as a phreatic system with water moving generally south-east and east, water-table lowering introduced vadose conditions which permitted stream erosion of passage floors and flowstone accumulation. After probably several phases of aggradation and erosion, conditions became such that the Breccia was introduced to the Cavern as a cold-climate multiple debris-flow deposit derived mainly from the shales and sandstones which form rising ground outside the former cave entrances. Blockage of these openings accompanied by climatic change allowed formation of the Crystalline Stalagmite to begin, and the Cavern entered a very long quiescent period (probably the order of 250,000 years; Proctor, 1994) when only flowstone accumulated. This sealed-off phase was abruptly terminated when new conditions allowed large quantities of extraneous material to flow through new (the present) entrances to form the Cave Earth in the Vestibule, Wolf's Cave, Great Chamber, Lecture Hall and Sally Ports. Where Cave Earth filtered down between large roof-fall blocks of limestone, filling voids, the faunal and archaeological sequences were rendered diffuse (Dowie and Ogilvie, 1927). Deeper in the cave there is evidence for renewal of stream activity with erosion of Crystalline Stalagmite and Breccia along the Long Arcade and South West Chamber and deposition of reworked Breccia material in the Wolf's Cave and Gallery, prior to Cave Earth deposition (Proctor, 1994). Sediment penetrating innumerable roof fissures formed thin patches of Cave Earth in the rest of the system. Eventually these conditions gave way to more speleothem accumulation (Granular Stalagmite).

The point to emphasise here is that after the long period when the cave was sealed, physical circumstances inside and outside the cave changed rapidly and probably dramatically. Minor and major openings appeared, the floors of the Vestibule and Wolf's Cave were lowered later to receive Cave Earth and there was much roof collapse. These circumstances coincided with and are probably related to one which affected the Crystalline Stalagmite (Straw, 1995). Both

MacEnery and Pengelly were impressed by the large number of blocks of Crystalline Stalagmite in the Cave Earth, and by the cracked and disrupted appearance of the Crystalline Stalagmite floor and some of the bosses in the inner half of the cave (Pengelly, 1869; 307, 309; Pengelly, 1884; 233, 362-3, 371-2, 378). For example, in the Lecture Hall huge cuboidal, sharp-edged masses of Crystalline Stalagmite in the Cave Earth were considered parts of a floor fractured along planes at right and other high angles to its upper and lower surfaces, and in the Bears' Den (Figure 1) the Crystalline Stalagmite, averaging 0.6m thick, was cracked into large slabs resembling flagstones in a pavement and only because of this was susceptible of excavation. Pengelly favoured a combination of roof-block fall and water pressure beneath the Stalagmite as the dominant causes, but because of insufficient air space in places on the one hand (*eg* Clinnick's Gallery) and difficulty on the other in producing high water pressures beneath the Crystalline Stalagmite where it was discontinuous as in the Labyrinth and over wide areas with air spaces above as in the Cave of Inscriptions, such processes would have been localised. Dislocation on the manifestly large scale could have been simultaneous throughout the Cavern and for such disturbance an external energy source would seem necessary. Vibration or a shock wave might have been generated by collapse of former adjacent parts of the Cavern system but, alternatively and probably more likely, a substantial earth tremor could have shaken the limestone mass, shattering the Crystalline Stalagmite (especially along and close to certain of the more important joints), easing joints and blocked passages to allow entry of surface materials and water, causing collapse of the floors of the Vestibule, Sloping Chamber and Wolf's Cave into lower-level voids similar to those like Smerdon's Passage beneath the south entrance and the Great Chamber, and thereby providing circumstances for the renewal of some stream activity in the Cavern and later the ingress and accumulation of the Cave Earth.

Kent's Cavern therefore most probably contains, in addition to its invaluable fossil faunas and artefacts, direct evidence for a Quaternary earthquake (Straw, 1995). Stratigraphically it would have occurred after Crystalline Stalagmite accumulation and before deposition of the Cave Earth. Proctor (1994, 1996) infers from speleothem dates and faunal comparisons that the Crystalline Stalagmite ceased forming soon after *c.* 115,000 BP, and that Cave Earth deposition began at about 74,000 BP. The earthquake is therefore a postulated Early Devensian, Stage 5, event.

Finally, Proctor's dates on the Crystalline Stalagmite bear strongly on another contemporary Quaternary issue. The Stalagmite was almost certainly accumulating by 350,000 BP and it is manifestly younger than the Breccia. The latter represents a long and complex cold phase, and contains Acheulean hand-axes in secondary and some 'Cromerian' fossils (Bishop, 1996). It is tempting to regard the Breccia as of Anglian age; if it is so, and if the Anglian correlates with Stage 12, then Kent's Cavern could take a place with Westbury-sub-

Mendip and Boxgrove as a locality of importance in the first appearance of man in Britain.

Kent's Cavern therefore still has great relevance for Quaternary scientists and the opportunity for further research, and the Annual Field Meeting visit was too brief to gain full appreciation of its past, present and future contributions to the understanding of Quaternary events. This note has sought to draw attention to the nature and exploration of the sediments, to the contrasts between the inner and outer halves of the cave system and to evidence for an Early Devensian seismic event.

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METHODS

A MODIFIED VERSION OF A POLLEN PREPARATION SIEVE

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Most pollen preparation procedures involve sieving samples in order to concentrate the pollen and facilitate counting. An aperture of 100-120 μ m is thought to be most suitable, allowing pollen and spores to pass through the sieve whilst retaining larger particulate matter (Barber, 1976; Moore *et al.*, 1991).

Sieves that are purchased generally have a firmly sealed mesh and are non-replaceable. When the mesh splits from its seal the sieve is useless. The average cost of the sieve can be up to £35 and therefore replacing sieves can be expensive.

An alternative sieve is presented in Figure 1. The sieve is made from a 40mm expansion coupler. It is approximately 57mm in height and has a sieve diameter

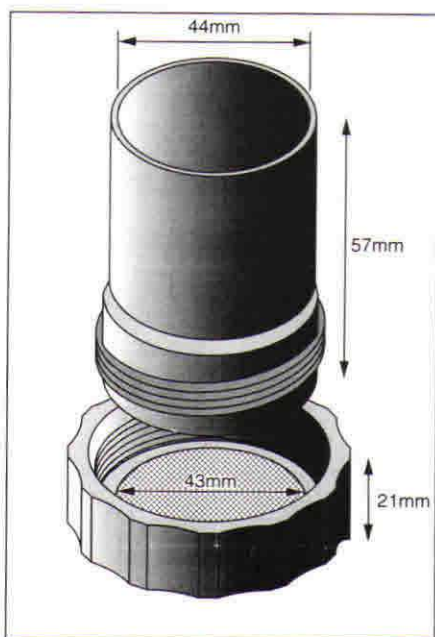


Figure 1. An alternative pollen sieve.

of 43mm. The base of the coupler simply unscrews from the top tube. Inside the basal part of the coupler there is a rim with a width of about 5mm on which a piece of mesh can be placed. The upper tube is screwed back on to the lower part of the coupler and tightly seals the mesh in place to create a sieve. The lower part of the coupler is deep enough (21mm) to prevent any leakage.

The advantage of using this sieve is that the mesh can be replaced and the coupler can be re-used. Furthermore, the coupler is also cheap, retailing from any good DIY store (B&Q) at approximately £1.25 per coupler.

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REPORTS

REPORT OF THE UCC/ICELAND '150' EXPEDITION TO NORTH-EAST ICELAND

July - August, 1995

Iceland has been the focus in recent years of many interdisciplinary research studies concerning Quaternary science from numerous universities. Here we report the preliminary findings of the first Irish Expedition to Iceland concerned with Quaternary science. Originating from University College Cork, this inter-university expedition involving institutions from Ireland, the UK and Germany took place from early July to mid-August 1995.

The expedition was based on Iceland's north-eastern Melrakkaslétta Peninsula, with research being undertaken upon two main themes: (1) Coastal environmental functioning and (2) Geophysical studies - earth gravity changes at plate margins. Further details of these themes are given below.

The Melrakkaslétta Peninsula is notably under-researched (Escritt, 1986; Ingólfsson, 1991), although work on the glaciology and sea-level history of the area has been initiated (Pétursson, 1991). Geomorphologically the area is varied, having been affected by post-glacial volcanic and tectonic activity, with areas in the east showing evidence of glacial erosion during the last glacial stage (Pétursson, 1991). Much of the inland area is above 300m, and is covered with many small lakes and mires. The coastline ranges from glaciofluvial sandur plains, volcanic sand beaches and boulder barriers to cliffs composed of lava flows, intercalated tillites and hyaloclastites.

Many sites in this study were located on the western side of the peninsula, although work was also carried out near Raufarhöfn and further south at Kollavík and Sæverland on the eastern side (see UCC 150 Expedition Report, Departments of Geography and Geology, University College Cork).

Research Theme 1

Within this theme, wider research was concerned with four goals, as follows:

Study of sea-level change and coastal stratigraphies Research into the impacts and evidence of sea-level change across a spreading ridge is already underway in north-east Iceland, in the form of NERC-funded Ph.D. research at Royal Holloway, University of London, by **Shaun Richardson**, along with **Jim Rose** and **Lewis Owen**. This research upon coastal morphology and

evolution is also linked to work on the glacial history of the area. The work of the UCC '150' Expedition concentrated more upon the analysis of coastal stratigraphies and sediments derived from a wide range of coastal sites, including Kópasker (16°28'W, 66°17'N) (Jonsson, 1957). Here stratigraphic and resistivity work was undertaken, showing the sedimentary sequence to be dominated by sands (>30m). An initial examination of the diatom flora from the upper part of this sequence suggests deposition in a fresh-brackish water environment. Stratigraphic investigations were also undertaken further south at Sveltingur (16°29'W, 66°11'N). Pétursson (1991) has worked here earlier upon the glacial and late-glacial history. Work upon the diatoms and sediments from cores in this area is now in progress to investigate the possibility of Holocene marine inundation.

On the east of Melrakkaslétta, cores to a depth of c. 5m were taken near Raufarhöfn (15°56'W, 66°0'N), as well as from Sæverland (15°44'W, 66°13'N), further south along this coast. Both sites are situated close to present-day sea level, and are formed by rock-lipped basins behind beach barrier structures. In addition to these sites, higher-level lakes and rock basins were also examined, but these appear to contain only a thin sediment sequence. From an initial overview of the sites studied, the stratigraphies suggest possibly that isostatic uplift on the Melrakkaslétta Peninsula has been rapid since glaciation, and that only in the later Holocene have isolation basins and coastal sites undergone renewed marine inundation.

Evidence of the impacts of tsunamis and storm surges upon coastal environments A further interest in the coastal stratigraphies is the possibility of finding deposits resulting from coastal tsunamis associated with the Storegga slides (Dawson *et al.*, 1993). Hansom and Briggs (1991) have suggested that deposits resulting from a tsunami exist in the north-eastern fjords of Iceland. However, this is the only site in the country known so far to record such sediments. Consequently the sites described here are being examined to find such deposits. Examination of cores shows little evidence of clear tsunami records of the form indicated by Dawson and his co-workers for other regions.

Operation of coastal sedimentary processes upon paraglacial regions Iceland's recently deglaciated coast provides a baseline for comparison with older paraglacial coasts further south (*ie* in eastern North America and Europe; Forbes and Syvitski, 1994). The work underway in Iceland potentially provides a link between established research on the Canadian Maritime Province Coasts (*eg* Orford *et al.*, 1991), and European Union-funded work upon Atlantic Margins (CEC, 1995).

The coastal environments around Melrakkaslétta are again quite varied in form. On the western and northern sides of the peninsula large cobble barriers and beaches are found; these materials are derived possibly from reworked till under conditions of rising sea level. On the eastern side, however, the beaches

are composed of much finer sand, supplied from the sandur plains further to the south. Work on beach environments along the western coast is concerned with two beaches at Magnavik ($16^{\circ}29'W$, $66^{\circ}14'N$) and Sveltingur. This work consists of both detailed beach profiling and sediment sampling, upon which particle size and mineralogical work is now in progress. The linkage between this work and the use of stratigraphic studies is of value as a means of characterising both present and past high latitude coastal environments.

The impacts and controls of tectonics upon coastal evolution Iceland is a region in which tectonic controls (*ie* crustal subsidence/uplift) are of fundamental importance in coastal change: almost instantaneously changing coastal position, and with longer-term repercussions for coastal shape, sediment supply zonation and biological habitats. Little is known about the record of such changes from the North Atlantic, though studies upon tectonically active coasts have been undertaken in the Mediterranean and elsewhere (see Devoy, 1987). These factors are of particular concern at the Kópasker site where ongoing seismic and crustal movement possibly plays a large role in the present-day evolution of the coastline.

Research Theme 2

This centres upon geophysics and earth crustal processes. Work undertaken in Iceland by UCC, in conjunction with research groups from the University of Iceland, The University of Jena and The Johannes Gutenberg University, Mainz, is concerned with the measurement of gravity in the Krafla area of north-east Iceland. This survey will give insights into the underlying crustal density structure. The 1995 survey will be compared with a similar one taken shortly after the last eruptive episode of the Drafla System in 1984. This comparison will enable conclusions to be drawn about the eruptive history and the likelihood of another eruption in the near future. This area of research will contribute to the coastal studies, in relation to questions of differing mantle viscosity and mantle controls upon relative sea-level changes.

In addition to these major research themes, research was also carried out upon upland sites near to the Jókulsá Gorge ($16^{\circ}27'W$, $65^{\circ}59'N$). This involved the investigation of a number of sites with a view to obtaining an outline of the tephra stratigraphy of the area, as well as obtaining a core for the study of vegetation changes in the region. This area was also the site for investigations of a range of periglacial features.

Acknowledgements

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THE QUATERNARY OF THE LOWER REACHES OF THE THAMES: SHORT FIELD MEETING

13th-16th October, 1995

A group of over 80 Quaternary scientists, including visitors from Poland and The Netherlands, attended this four-day meeting, led by **David Bridgland** (Durham), **Pete Allen** and **Andrew Haggart** (London Guildhall). The bustling Essex holiday resort of Southend was the base for this comprehensive field trip to the Lower Thames. Yes, Southend does buzz in October!

Day one of the trip began with a visit to the classic site at Hornchurch Railway Cutting. Due to the hazards of allowing QRA members into the railway cutting, which is owned by Railtrack, only six people at a time were permitted to view the section. The correct colour of reflective waistcoats had to be worn and after climbing over the fence using two pairs of stepladders, the groups were 'watched' by a railtrack lookout. **Colin Whiteman** (Brighton) explained how the lodgement till at Hornchurch is the most southerly deposit from the Anglian ice sheet and is overlain by Boyn Hill/Orsett Heath gravels. This evidence has been used to suggest that the Lower Thames terrace system post-dates the Anglian glaciation.

Next stop was Barnfield Pit, Swanscombe NNR, led by **David Bridgland**, **John McNabb** and **Nick Ashton** (British Museum). At this site, famous for among other things the Swanscombe skull fragments, the group was greeted by the Mayor, members of the local council and representatives from English Nature. Three sections had been cleared for the visit and a number of interesting points were raised in discussion including a debate between **John McNabb** and **John Wymer** concerning the reasons for variations in artefact assemblages at Swanscombe: raw material supply or cultural evolution? Most people also found the small, permanent exhibition in the foyer of the nearby sports centre worth a quick look.

Francis Wenban-Smith (Southampton) led the visit to the third site of the day, the Ebbsfleet Valley complex. This is an important site, rich in archaeological material and faunal remains, recorded from sediments deposited by the Ebbsfleet River. The discussion concerned how the remaining deposits at Northfleet could be related to the poorly-logged sections of earlier workers. On a wider scale, an attempt was made to correlate these with the Thames system. **Rob Kemp** (RHUL) then led the group to view the buried palaeosol from the Middle/Upper Loam and discussed the complex soil development history, highlighting the difficulties of interpreting buried soils.

The final stop of the first day was Wansunt Pit SSSI, Dartford Heath, where Thames terrace gravels of controversial age are seen overlying Palaeogene Thanet sands. The top of the sequence is marked by the Wansunt Loam, which

is rich in palaeoliths. An interesting debate ensued between **David Bridgland**, who attributes the gravels to the Boyn Hill/Orsett Heath formation, and **Phil Gibbard** (Cambridge) who believes that they correlate with the Black Park gravels of the Middle Thames. Day one was rounded off with a cry from the back of the bus, "we need a pub that sells Green King IPA!".

Purfleet Chalk Pit SSSI, the first stop of day two, was led by **David Bridgland**, **Pete Allen** and **Danielle Schreve** (Natural History Museum). Newly-dug trial pits provided excellent exposures for the visit and Danielle treated the group to a display of recent finds, including a finger bone from a Macaque monkey previously unrecorded at this site. **David Bridgland** and **Phil Gibbard** both presented their interpretations of the site which ranged from an early course of the Thames abandoned in the late Middle Pleistocene (Bridgland), to deposition by a Late Pleistocene Mar Dyke tributary (Gibbard). Lunch followed at West Thurrock with a fine view across the industry-lined course of the present-day Thames!

The afternoon began with a visit to Lion Pit Tramway Cutting SSSI where **David Bridgland** and **Phil Harding** discussed the history of the site and proudly displayed a newly-excavated section which showed the full sequence of basal gravels with artefacts, laminated silts (possibly estuarine in origin) and brickearth. Artefacts collected from the site were on display courtesy of **Phil Harding**.

Late afternoon saw the division of the group, with many remaining at Lion Pit, whilst the rest travelled on to Star Lane, a disused brickworks with exposures of primary loess, exceeded in thickness only by the deposits at Pegwell Bay, Kent.

Day two was rounded off with a visit to Foulness. As this is MOD land and access is restricted, the group was privileged to be shown the chenier ridges which form the largest shell spit in Britain. At a reception in the local pub, presentations were given by **Antony Sutcliffe** (Natural History Museum), **Jeff Blackford** (Durham), **Peter Murphy** (East Anglia) and **Andrew Haggart**.

Sunday morning was a rude awakening to those with inadequate footwear! - a visit to the Couch Estuary, led by **Peter Murphy**, where discussion concerned the sequence of terrace gravels, palaeosols and estuarine sediments evident in the inter-tidal zone.

The afternoon was spent at East Mersea visiting two sites. The first, the Restaurant Site, was led by **Andy Carrant** (Natural History Museum). The group was called away from lunch in the pub as Andy was waiting in the hole and the tide was coming in! Discussion here centered around the age of the deposits and the implications of the presence of hippo. The second site at Cudmore Grove, an interglacial site with a fossiliferous channel fill overlain by Thames-Medway gravels, was presented by **David Bridgland** and **Helen Roe** (Bangor). Helen gave a comprehensive account of her research into the environmental history of Cudmore Grove. On the return journey back to



The Swanscombe debate: John Wymer and John McNabb discuss the reasons for variations in artefact assemblage.



Examining a display of local finds, collected by Ron Wrayton during the visit to East Mersea.

Southend, **Colin Whiteman** took a small "unofficial" group to Maldon Cutting, the type site for the Maldon Till, to discuss whether the till was an *in situ* deposit and also the nature of deposition of the gravels lying above the till.

On the final day, the group was split and could decide to visit either Thames estuary Holocene or Tendring Plateau sites. The Tendring Plateau excursion began at Curry Farm, Bradwell, led by **Phil Gibbard**. Basal gravels were seen

overlain by a coarsening-up sequence of silts, sands and gravels. Gibbard argued that the upper part of this sequence represented deposition in a prograding delta system. **David Bridgland**, who had previously interpreted the deposits all as being fluvial, suggested that in the light of new research interpretation of the sequence may be open to discussion. Amongst the party there was a healthy mixture of acceptance and scepticism with regard to the delta.

The next stop was Ardleigh SSSI where the upper part of the sequence was evident. **Pete Allen** explained how the lower gravels were pre-diversion Thames deposits, above which was a gravel unit containing different lithologies, in particular *Rhaxella* chert. The upper part of the sequence, with palaeocurrents to the south-west, is thought to have been deposited by a tributary river. The sequence is capped by a palaeosol believed to be the Valley Farm Soil.

After lunch, the group split with half going directly to Walton-on-the-Naze, whilst the rest travelled to Wivenhoe SSSI with **Pete Allen**. At Wivenhoe, interglacial sediments were seen between two gravel units and the discussion centred around two cold stage accumulation phases being represented within one terrace. The day concluded at Walton-on-the-Naze to discuss the Pliocene Red Crag beds and the origin of the overlying Pleistocene fluvial deposits and brickearth.

The Holocene day began with a visit to West Tilbury marsh, which was something of a pilgrimage for those interested in sea-level change as the area has been the focus of some of the most important Holocene sea-level studies in the Thames. **Professor Skempton** (Imperial, London) discussed the effects of reclamation on the stratigraphy and geotechnical properties of clays and peats. Next Haggart and colleagues attempted to resample **Bob Devoy's** type site in the Lower Thames- the wonderfully named 'World's End'. The main peat bed in the area, known locally as Tilbury III, was reached but unfortunately not penetrated to any degree, such was the degree of compaction. After lunch the group crossed the Thames and went on to the Lower Medway Valley, where **Tony Barham** (UCL) *et al.* described the Holocene stratigraphy of the floodplain area, using data collected as part of the environmental investigations accompanying the construction of the Medway Tunnel. (*Contributed by Anthony Long, Southampton, as the author could not be in two places at once!!*)

After four days of visiting the majority of the classic Lower Thames terrace sites, the group dispersed, generally content and certainly much the wiser. The 'soon to be published' Lower Thames field guide is a treat worth waiting for!

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PERSPECTIVES ON THE HOLOCENE ENVIRONMENTS OF PREHISTORIC BRITAIN: ANNUAL DISCUSSION MEETING, UNIVERSITY OF SHEFFIELD

4th-6th January, 1996

The Quaternary Research Association Annual Discussion Meeting, which this year was joined by the Association for Environmental Archaeology, promised a post-Christmas tonic of lively debate and discussion. A conference such as this in which archaeologists, environmental archaeologists, palaeoecologists and Quaternary scientists come together to consider common ground is rare, and the potential interest of such a meeting was enticing enough to draw delegates away from their New Year contemplations to converge on the University of Sheffield. Expectations were amply rewarded. The range of papers presented was diverse; some were challenging and controversial, others were novel and several old favourites had their first airing of 1996. The Holocene seemed to emerge from the seasonal mists of time like a 3-D jigsaw puzzle from a Christmas stocking which all were intent on reconstructing. But were we all looking at the same picture: the big picture or just at a piece of the puzzle? How opposed/similar were the different perspectives and, perhaps more fundamentally, were all the pieces in the box? From the initial jumble of pieces a number of underlying themes emerged, principally those of temporality, spatiality and variability with respect to the analysis and interpretation of data and the diversity of perspectives underpinning research into Holocene people/environment interactions.

Day 1 - Archaeological Views

The opening session comprised a succession of papers from archaeologists. **Steve Mithen** (University of Reading) focused on the Mesolithic with particular reference to his long-term southern Hebrides project. **Mark Edmonds** (Sheffield) discussed general themes of the Neolithic in Britain, **John Barrett** (Sheffield) woke everyone up with a challenging paper on landscape biographies in the Bronze Age and **Ian Ralston** (Edinburgh) concluded the chronological sequence with a review of the Iron Age. These speakers provided an overview of how archaeological research is currently approaching each of these prehistoric periods (and their transitions). They also defined a series of specifically archaeological problems which they felt could be informed by palaeoenvironmental research. Importantly, the archaeological contributions reminded delegates that the Holocene provides few opportunities to consider environmental systems operating without anthropogenic modification. **John Barrett** made the point that bringing together environmental and archaeological questions can produce a dichotomy, that of the complexity of human culture versus a systems approach to the environment. He suggested that such an approach had not been productive in the past and that the time had come to try

a more holistic, hermeneutic approach which places people *in* the environment and recognises that the past was inhabited by people who understood their landscape culturally and exploited it strategically. These interactions had (and still have) both symbolic and functionalist aspects. The emphasis of research in each archaeological period appeared to be aimed at addressing issues of variability at a series of temporal and spatial scales (regionally, locally annually, seasonally, daily). Particular themes included the episodic use of space in prehistoric geographies, the difficulty of establishing the *detail* of landscape and land-use change and an emphasis on interactions *across* the landscape, particularly the organisation of space and the creation of place. Movement in the landscape was emphasised as a significant aspect of spatial organisation, important to hunter-gatherers and the later Neolithic pastoralists. **John Barrett** and **Mark Edmonds** both discussed the changing role of environmental research in archaeology suggesting that in the past archaeologists may have viewed environmental research as an ancillary project to archaeology with the result that it has too often been relegated to a lower status within the discipline (rather like the contrasting status of scenery painter and movie actor in a Hollywood film set). As a consequence, environmental evidence may have been used in simplistic ways by archaeologists either to paint the backdrop against which human activity is set or to support functionalist interpretations of people/environment interactions (much to the frustration of some environmental specialists who have experienced the consequences of this attitude on working practices and gender/employment issues in environmental archaeology). One positive theme to come out of this session was the need for new theoretical and practical approaches to archaeological questions of environment/people interactions.

Day 2 - Environmental Approaches

Major themes which emerged from this session included the relative importance of anthropogenic and natural factors as causes of change, variability at all temporal and spatial scales, and chronology. The first paper in the session, presented by **Brian Huntley** (Durham) gave a resumé of the climate simulation models for the Holocene, a study which has provided signals for Holocene climatic change in 3,000-year time slices and a provisional framework for consideration of climate-driven ecological and cultural interactions. The time spans and resolution of the climate models illustrated rather neatly a difficulty mentioned by archaeologists in the preceding session; that of integrating the local/regional scales of site-based studies with larger abstract models.

Variability, at all temporal and spatial scales, was emphasised in relation to sea-level change (**Michael Tooley**, St Andrews), riverine contexts (**Mark Maklin**, Leeds) and Holocene pedogenic processes (**Donald Davidson**, Stirling and **John Catt**, IACR-Rothamsted). All speakers stressed that Holocene geomorphic systems were characterised by multi-directional change and that in Britain

regional signals were different depending on the magnitude, frequency and extremity of events and the sensitivity of a situation to perturbations which may have been exacerbated by different land-use histories. These systems have been characterised, in the Holocene, by periods of episodic change: typically high levels of erosion, sea-level fluctuations and flooding, separated by periods of relative equilibrium. This concept of no steady state was echoed throughout the conference as characterising many aspects of natural systems and human cultures. This series of papers generated a number of thought provoking problems which environmental researchers thought could be informed by archaeologists. In relation to climate change, **Brian Huntley** questioned if it was possible to detect in changing settlement patterns the processes and time scales for human adaptive response to climate change. In relation to Holocene sea level, **Mike Tooley** asked archaeologists to consider the response of prehistoric people and coastal communities to fluctuations in sea level and consequent changes in coastline configuration; what was the cultural response to this variability and was there any evidence to suggest how coastal communities were affected by storm surges/extreme events? Similar themes emerged in the context of settlement and environmental interactions in river systems. On a more pragmatic note, also emphasised by other speakers, **Mark Macklin** reiterated the need to continue and expand systematic archaeological survey of river catchments and valley floors. He put out a plea to archaeologists to get geomorphologists in at the research design stage of a project and to join in the NERC's LOIS initiative which (incredibly) currently lacks any archaeological input.

Several speakers dealt more specifically with problems associated with aspects of data analysis, interpretation and coverage in a UK context. Papers generally focused on the nature of the questions addressed by environmental research and the quality/coverage of data available to answer them. **Kevin Edwards** (Sheffield) demonstrated the contrasts in coverage between southern Britain where the archaeology survey data are fairly comprehensive, but where there is a lack of environmental data, and the north where there are abundant pollen records. Here the environmental coverage appears at first glance to be good but the quality, particularly of radiocarbon dating evidence, is sometimes poor, especially with respect to interpreting anthropogenic impacts - problems which are further exacerbated by a lack of archaeological detail for the region. This point was further emphasised by an example of work in the Outer Hebrides where, during the Mesolithic, pollen and charcoal records suggest the presence of people, but as yet there is no archaeological evidence to substantiate this hypothesis. Kevin also raised the spectre of interpretative models of forest farming which could turn all our interpretations of palynological clearance signatures on their heads and reiterated the point that there was no correspondence between the early *Corylus* rise and anthropogenic fire. These issues of data analysis and the coherence of the fossil record were continued in other papers. **Paul Buckland** (Sheffield) and **Jon Sadler** (Birmingham) emphasised the

patchy nature of palaeontomological records and the problem, once into the Holocene, of disentangling human and naturally induced changes observed in the fossil record. **Martin Jones** (Cambridge) addressed more archaeological questions, particularly those associated with the scales and tempi of human activity. He asked if we were any closer to quantifying the scales of human activity in the past and also what forms of human ecological agency are consistent both with the social landscapes of prehistory and the Quaternary record. **Martin Bell** (Lampeter) expanded on many of these earlier themes and discussed current interpretative frameworks which are dominated by autecological approaches and uniformitarian assumptions. Examples illustrated the weakness of these approaches to molluscan records, particularly from archaeological contexts which are rendered problematic by factors such as stochastic colonisation, the lack of modern analogues for prehistoric habitats and what Martin described as the 'otherness' of the past. In spite of these difficulties, Bell's paper also demonstrated the usefulness of environmental evidence in challenging archaeological assumptions and the equally challenging environmental questions which arise from the archaeological record. The theme of data interpretation was continued with a paper from **Tony Legge** (London) who, in common with other speakers, pointed to the inadequacies of the Holocene fossil record, this time in relation to faunal remains. The main thrust of this paper was to illustrate the point that human use of the landscape does not reflect its potential but rather the social relations and perceptions of people. The discussion focused on alternative interpretations of the animal bones from Star Carr and concluded that, in contrast to earlier interpretations, the range of the assemblage reflected complex on-site processes rather than a diverse environment. The complexity of disentangling the social from the environmental also preoccupied **Andrew Chamberlain** (Sheffield) who considered the way in which the remains of past people inform environmental reconstruction. He suggested that theoretical approaches to people/environment interactions had moved on from a notion of culture as something which protects people from a hostile environment to a more complex view, illustrated by examples where changes in social behaviour increased the exposure of populations to disease and hunger. The message was simply that resource use and demand are not just driven by deterministic factors such as population pressure, but by social/cultural changes.

After a welcome break for tea the conference reconvened for the last session of the day to consider the **View From Outside**. No time now for a cosy afternoon snooze, Gandalf had arrived (disguised as an Irish dendrochronologist), blowing coloured (tree) rings, sprinkling volcanic and cosmic dust into the air and relegating the parochial to the back-burner. For all those fiddling with puzzle pieces here was a chance to see the big picture and think about correlations which sent the mind spinning. **Mike Baillie** (Belfast) explored whether there could be a link between the Fennoscandinavian temperature index, the mean European oak index, volcanic activity and catastrophic events such as plague

and famine? Were these mere terrestrial expressions of something much more significant, a sort of global but regionally variable response to external intervention? It was 4.30 in the afternoon, I heard someone whisper that licensing restrictions should be lifted, since the end of the world seemed nigh and we might as well get to the bar! As a double falsification and tonic was at least an hour away a clash of the titans (Buckland v Baillie) seemed a possibility. However good time keeping prevailed and the session was concluded by **Willy Groenman-van Waateringe** (Amsterdam) with a paper which reviewed the timing and causes of irreversible environmental change in The Netherlands. We then adjourned to the bar - anticipating catastrophic events. Sadly they materialised later in the form of a car thief who scattered glass shards and made off with Charlie French's belongings (- commiserations)

Day 3 Examples and Ideas

After an evening of Sheffield hospitality, the concluding session of the conference on Saturday morning was remarkably well attended. This session provided an opportunity for researchers to present papers on current projects at a variety of landscape scales which connected with many of the questions and themes raised by speakers in the previous sessions. An example of this was work being undertaken by **David Huddart**, **Sylvia Gonzales** and **Gordon Roberts** (Liverpool John Moores) looking at the archaeological record and mid-Holocene coastal environments in Liverpool Bay: a study which appeared to be addressing with considerable success some of the questions raised on Friday by **Mike Tooley** about the cultural response of coastal communities to sea-level variability. Similarly, two papers on different aspects of Holocene river valley landscapes, one looking at cultural opportunity and the preservation of archaeology in the Vale of York (**Peter Davies**, Bath College of Higher Education), the other characterising lowland environments using an integrated approach to data from a variety of smaller sites in the Soar and Nene valleys (**Tony Brown**, Exeter) addressed many of the issues raised by **Mark Macklin** in the Friday session. The theme of landscape-scale studies continued in the rest of the session. **Graeme Whittington** (St Andrews) outlined the potential for landscape-scale soil pollen analysis from open areas where past land surfaces were sealed by peat. Pilot studies have shown the great potential for this little-used approach. **Caroline Skinner** and **Rob Young** (Leicester) and **Tony Brown** discussed prehistoric landscape reconstruction in eastern Cumbria and **Chris Caseldine** concluded the session by considering the problems of correlating environmental and archaeological interpretations of landscape change on Dartmoor.

After coffee, a series of papers examined the potential of less commonly used techniques and new approaches to the more familiar. Contributions ranged from delightful commensals (**Elizabeth Somerville**, Sussex) to the not so immediately endearing chironomids, work in progress by **Esther Hawtin**

(Birmingham), **Jon Sadler** and **Kevin Edwards**. **Nicki Whitehouse** (Sheffield) discussed the impact of natural fire in creating clearings and habitats for colonisation by Holocene beetle taxa and the great difficulty in interpreting an anthropogenic/natural cause for disturbance signals in the palaeoentomological record. **Martin Everson** (Sheffield) concluded the conference with a stimulating paper on the potentials and problems of human DNA research. He reminded us of the human potential for survival, that despite all the hazards which had beset our ancestors we can marvel at the moral fortitude of the last solitary adult male left on the Pitcairn Islands and finished on the optimistic, consoling note, that human beings find ways of spreading their genes whatever their ideological differences.

In concluding, I would like to mention a few comments that were passed on to me at the conference. Several delegates (male and female), commented on the small number of women speakers, and several felt that there had been insufficient opportunity for discussion, many contentious issues had failed to get a full airing - a price paid for the immensely rich diversity of perspectives on the Holocene which were on the agenda. Finally, I would like to take this opportunity to congratulate **Kevin Edwards** and members of the Department of Archaeology and Prehistory, University of Sheffield for hosting and organising such a successful programme. I hope that the opportunities provided by a joint conference of this nature have helped to inform archaeologists and environmental specialists of the potential for interdisciplinary projects. In reviewing the conference I am struck by the many similarities rather than differences between the two groups, particularly as a new generation of researchers recognises the need for good science and good theory as well.

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THE FIFTH BGRG SUBGLACIAL PROCESSES WORKING GROUP MEETING: ISLE OF MAN

14th-18th March, 1996

The BGRG Subglacial Processes Working Group met for its fifth meeting on the Isle of Man, where twenty people from all levels of academia contributed to a lively weekend viewing a wide variety of the Manx Quaternary deposits. This meeting was led by **Roger Dackombe** (Wolverhampton) and **Geoff Thomas** (Liverpool) and they opened the meeting on the Friday morning with a brief introduction to the island's Quaternary history. It was stressed that much of the work and interpretations that were to be presented were carried out some twenty years ago, and they would welcome alternative ideas, since limited studies had been produced since then.

After a brief run around the Manx Museum in Douglas, the first site visited was Ballure on the eastern coast. Here, the only chronostratigraphical datum on the island could be found in the Ipswichian buried cliff, which is overlain by local diamicts. A small-scale debate developed as to the origin of the diamicts: they could be periglacially reworked, locally derived tills or bedrock broken down *in situ*.

Further to the north is Dog Mills, where a sequence of laminated sands and silts has provided differing interpretations as to their origin. The glaciomarine model of Eyles and Eyles (1984) was supported by **Endarf Edwards** (Carmarthen) who has found the area to provide rich samples of marine microfauna in the basin to the south of the Bride Moraine. Some specimens are well preserved indicating that little transportation had taken place. **Geoff Thomas** concurred that these sediments are perhaps the single best evidence for a glaciomarine depositional environment, although **Roger Dackombe** suggested that they were glaciolacustrine deposited by a pre-glacial lake trapped between the Manx uplands and the Bride Moraine.

After a brief stop for lunch, the work continued to the north of Shellag Point, where much attention was placed on the discovery in the foreshore of the Shellag Till, a clast-poor diamicton, thrust as pods into the overlying Ballavarkish Till revealing large-scale augen structures of the Shellag Till in the Ballavarkish Till. These exposures had not been seen in such a manner for many years and provided great comfort to the subglacial deformation theorists.

Saturday morning was damp. Undeterred, the group headed off to the east coast once again for a more detailed analysis of the Bride Moraine at Shellag Point. Exposures on the foreshore revealed tectonic structures that had not been seen for many years. Arguments ensued as to the origin of the landform and the glaciotectonic structures within it, based either on the Eyles and Eyles (1984) model of a subaqueous push ridge or the more widely held view that it was

formed during glacial retreat and readvance. **Roger Dackombe** believed that the subaqueous push ridge would not have been able to support itself in the present form. This is allied to the lack of marine microfauna and the presence of frost-shattered debris in the Shellag Formation which suggests deposition in a terrestrial glacial environment.

The final day started at Glen Moar, where a head deposit comprising Manx Slates has been overridden by ice. A lengthy discussion as to the validity of the glaciomarine model ensued. **Roger Dackombe** and **Geoff Thomas** suggested that there is little evidence to support these ideas: there are no inland sites with *in situ* marine microfauna, there are no erosional features such as raised shore platforms and a distinct lack of draped rain-out muds. **Endarf Edwards** suggested that there was evidence for glaciomarine deposition at Dog Mills as stated earlier.

The group then moved along the coast toward Orrisdale Head, taking in Glen Ballyre, where two diapir spurs 8m high, comprising the Wyllin Till facies, flanked a basin. The diapirs displayed evidence of soft-sediment deformation including pipe and ball features. Lunch was taken beneath Glen Ballyre kettle hole where the conversation concentrated on the likely formation of the depression rather than the controversial biological evidence which it contains.

On arrival at Orrisdale Head, **Roger Dackombe** briefly ran through his interpretation of the Orrisdale Till as a subglacial lodgement till, noting consistent orientation of striae on the surfaces of bullet-shaped clasts with strong a-axis orientation. Considerable ice thicknesses were envisaged with evidence of stone collisions producing a short trail of fine-grained detritus. Sand lenses within the Orrisdale Till were interpreted by **Jane Hart** (Southampton) as the homogenised facies of the Ballavarkish Till. Further up the sequence, debate centred on sheared sand pods which were suggested to have resulted from reductions in pore water pressure as the ice retreated (**Jane Hart**) or watering dilation governed by effective pressure (**Dave Roberts**, Liverpool).

The group bid hearty thanks to **Roger Dackombe** for his excellent all-round organisation. Thanks were also extended to **Geoff Thomas** for his help, which was swiftly returned in the form of an open invitation to continue studies into the Quaternary deposits. **Jane Hart** revealed that Ireland, Scotland or the East Midlands had thrown in bids for hosting the October meeting of the workgroup. This was an excellent trip, and all members are eagerly awaiting October's meeting.

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**POSTGRADUATE PALAEOECOLOGY CONFERENCE:
GODWIN INSTITUTE FOR QUATERNARY RESEARCH,
DEPARTMENT OF ZOOLOGY, UNIVERSITY OF
CAMBRIDGE**

1st-3rd April, 1996

The main aim of the PPC is to allow postgraduates involved in research within the general area of palaeoecology to meet and present their work to an audience of other postgrads working in similar(ish) fields. Frequently, a talk at a PPC represents the first paper a postgraduate will give during his or her career. With this in mind, a strict 'No Grown-Ups' rule is enforced to try and alleviate a little of the pressure that this can involve. Indeed, both of this year's organisers gave their first conference talks at previous PPCs.

Over 40 students from Britain and Ireland attended this PPC in Cambridge. After a relatively short opening session on Monday afternoon, a large contingent of delegates took to the Cam to try their hands at punting (with variable results!). Dinner that evening at Corpus Christi College was followed by an intensive session devoted to 'fieldwork' at several of the local hostelrys, coupled with the inevitable tales of punting bravado!

Tuesday witnessed talks from dawn 'til dusk (well nearly) on subjects as varied as land snail records in Western Europe, Neolithic archaeology in the Balkans, the palaeoenvironmental significance and interpretation of peat-based records using both pollen and testate amoebae, the problems and benefits of using ostracods as palaeoenvironmental indicators, and possible evidence for alternative landbridges by analysing the post-glacial colonisation of Britain by reptiles and amphibians. Other contributions (but by no means all) included a study of diatom successions from volcanic lakes in Italy, a fossil beetle record from the last interglacial - glacial transition, and the potential for analysing stable isotope geochemistry of benthic foraminifera. A successful day's academic toil was followed by another equally successful bout of 'fieldwork' around some of Cambridge's finest way-points, including a diversion to a local Mexican restaurant for the by now legendary PPC Conference Meal.

The final talks, some of them given by people looking rather green around the gills as a result of too much indulgence the previous evening, took place on Wednesday morning. Early Silurian palaeoceanography, Tertiary lizard fauna, the value of midges for palaeoclimatic reconstruction and the potential of foraminifera to be used as indicators for ancient tsunami events were amongst the topics discussed. Proceedings were wrapped up by a vote in which Edinburgh pipped Bangor at the post to have the honour of holding next year's conference.

In total, 28 talks and three posters were presented, the standard of which was uniformly impressive. The atmosphere was friendly and relaxed throughout and all the participants seemed to have enjoyed themselves, having benefitted from the contact with other like-minded postgrads. It is especially encouraging to note the wide diversity of topics presented, reflecting the broad range of palaeoenvironmental and palaeoecological work currently being carried out across the country - surely an indicator of a healthy and active field. It only remains for the organisers to thank the Department of Zoology and Corpus Christi College for their support, and all of the participants for their effort and constant enthusiasm. We wish the Edinburgh contingent good luck with the organisation of next year's conference.

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REPORT ON THE 1996 QRA FIELD MEETING TO THE CAIRNGORM MOUNTAINS, SCOTLAND

11th-12th May 1996

The first 1996 QRA Short Field Meeting was held in the Cairngorm Mountains, Scotland. The event was organised by **Neil Glasser** (Liverpool John Moores) who was assisted by **Matthew Bennett** (Greenwich) and **Martin Kirkbride**. The excursions were led by **Colin Ballantyne** (St Andrews) and **Adrian Hall**, with contributions from several others. Twenty seven people attended (although not the same twenty seven on both days), along with a dog called Badger and a very appropriately named dog called Corrie. The youngest scientist present, who is also one of the most knowledgeable, was **Andrew Benn** (aged 7).

The party was based in Rothiemurchus Lodge (*no bar!*), which is located close to the northern entrance of the Larig Ghru in Glen More. The exceptional quality and variety of landforms and the interesting nature of the Quaternary history of the area allowed the two days to be spent walking through the landscape rather than visiting a series of discrete sites.

Day 1: The Larig Ghru

After a brief introduction by **Neil Glasser** on the location and geology of the massif, a short walk took the party into the Larig Ghru - a major north-south glacial breach through the Cairngorms. Only brief stops were made on the hike south through the Larig to the mouth of Garbh Choire (a coalescence of several corries). The plan, which had been the subject of much debate during the previous evening, was that discussion would be better on the return journey. The weather remained dry, with only a slight breeze, in spite of a rather ominous forecast.

Garbh Choire was reached at about mid-day, after a few re-grouping and recuperation stops. While lunch was consumed, **Matthew Bennett**, establishing the theme for the weekend - spectacles, opened a debate on the moraines which extend out of the corrie and into the Larig Ghru. It appears that the interpretation of the landforms and sediments of the Cairngorms varies depending upon which spectacles you are wearing. During his speech the extremely technical term of "*Lumpy and Dumpy Moraine*" was used to describe these landforms. Of particular interest was the proposed age of the moraines. They have been associated both with the retreat of the Dimlington Stadial ice sheet and with Loch Lomond Stadial (LLS) ice in various papers by David Sugden and Brian Sissons respectively. One of the major difficulties seems to be distinguishing between moraines of LLS age and those associated with ice-sheet deglaciation. Assignment of LLS age to the former ice body presented further questions. These concerned the extent of the glacier; whether there was a small ice-dammed lake up-valley in the Larig Ghru; and, given the size of the glacier compared to less extensive moraines in other corries, if there was a small thin

ice cap over the Monadh Mor plateau (or a snow-blowing area) which nourished the glacier. Bennett (1996) further discusses the arguments involved.

The party then walked back along the Larig to the Pools of Dee, where **Colin Ballantyne** introduced the different types of talus slopes, which are spectacularly developed on both sides of the pass. Particularly fine examples of avalanche tongues, which extend on to the adjacent valley sides in some examples, demonstrated evidence of recent activity. Clasts were very angular, smaller clasts were perched on larger ones and vegetation debris lay on the surface of the tongues. Further north, numerous debris flows were seen to mantle the slopes. These have well developed levées, providing more easily entrainable debris for avalanches to rework. Without such a supply of debris, the spring avalanches have little geomorphological significance. On slopes with little current avalanche activity, levées remained prominent.

Landforms which were variously interpreted, depending upon one's choice of eye-wear, as rock glaciers, rock-falls, or moraines were clambered over on the eastern wall of the Larig - not discounting the possibility that they are rock-falls onto moraines which have subsequently deformed as rock glaciers. On the opposite valley wall a protalus (pronival) rampart was viewed. **Colin Ballantyne** then discussed the palaeoclimatic implications of rock glaciers and protalus ramparts.

The remaining portion of the day was devoted to the landforms and sediments associated with a former ice-dammed lake, which occupied the northern entrance of the breach. **Vanessa Brazier** and **Martin Kirkbride**, who had drawn attention to the moraines and dissected delta terraces earlier in the day, led the group to several sections. A moraine clearly marks the position of the Glen More ice. Subaqueous slumps and flows dip steeply from the former ice front towards the Larig. A high proportion of schist clasts, as well as the granite of the Cairngorms, was observed, confirming the westerly provenance of the ice. Lake-bottom sediments and foresets were also observed. The former exhibit rhythmic layering and the latter (building out from the Larig) were shown to contain no schist, indicating a local provenance. At the northern margin of the terraces an ice-contact slope was observed, with three terraces extending north from this line, thought to represent progressively lower lake levels. Several of the people who were in attendance commented on the similarity of this suite of landforms and sediments with those of more recently deglaciated areas. The preferred interpretation was that Dimlington Stadial ice flowed down the Spey Valley and into Glen More, causing water to pond between the lobe of ice and a local valley glacier in the Larig Ghru. Thus the Cairngorms were relatively ice free at a time when ice extended a considerable distance along the Spey Valley. Brazier *et al.* (1996) provide a more in-depth description and interpretation.

The discussion was then transplanted to Aviemore where the party was fed and watered at an excellent hostelry, with the English contingent returning early to

watch a video of the Cup Final. Those from Liverpool John Moores University were not in the best of moods (Manchester United 1-0 Liverpool). The younger members of the group exhibited their enthusiasm for their work by extending their conversations into the small hours.

Day 2: The Cairn Gorm Plateau and the Northern Corries

The second day began with the 'sermon on the mount' at the automatic weather station near the summit of Cairn Gorm. **Colin Ballantyne** said a little about present-day weather conditions on the plateau. He explained that, due to the harsh weather, the various instruments which measure the weather were hidden in a rather uninteresting cylinder, and appeared out of the top periodically. With amazing timeliness, he gestured to the cylinder which proceeded to make a whirring sound, and to everyone's amusement performed its act right on cue. The weather of the day was unusual for Cairn Gorm, with almost no wind at all. The plateau was cloaked in cloud on arrival at the upper car park, almost resulting in the excursion to the summit being cancelled. Once we reached the top of the chair lift, the clouds parted and clear sky followed the party about for the rest of the day. Perhaps the professors in the party had a word in God's ear?

A tor was examined to the east of the summit. **Adrian Hall** discussed the pre-Quaternary evolution of the plateau (*cf* Hall, 1996) and **Colin Ballantyne** talked about the models of tor development (*cf* Ballantyne, 1994).

After a bout of professorial sledging (**David Sugden**), a rock outcrop (which may be a *roche moutonnée*) was the focus of attention. This location, to the east of the summit on an erosional bench, is thought to be the upper limit of evidence of ice-sheet erosion. A discussion on the thickness of the ice and its thermal régime developed. Little evidence for an ice sheet, except a few erratics, can be found on the plateau surface. The plateau is, however, thought to have been covered by ice during the last glacial maximum. The observed lack of erosion on the plateau was put down to the presence of cold-based protective ice on these areas, while the deep glacial troughs enjoyed warm-based erosive ice due to the greater ice thickness. Brazier *et al.* (1996) summarise the current arguments, and Glasser (1995) presents a model for the last ice sheet in the area.

The group next stopped at the edge of the plateau at the top of a precipitous drop into Glen Avon. Moraines could be seen from this vantage point. These are thought to be of LLS age, although there was some debate as to the limit of LLS sedimentation and that left by the retreating ice sheet. Also noted were the dilation joints (pseudo-bedding) which are parallel to the plateau surface, but truncated by Glen Avon. The patch of cloud-free sky which had been following the group extended on command allowing the general rolling nature of the plateau surface with its deeply incised glacial valleys to be seen.

The party lunched on the snow-covered plateau looking down on to the LLS moraines of Coire an t-Sneachda. **Matthew Bennett**, with comments from

David Sugden (who mapped the Cairngorm area a *few* years previously), introduced the landforms of the corrie. These were clear boulder moraine ridges and boulder limits. Again, there is no dating evidence, so a LLS age can only be inferred. The group descended into the corrie to discuss what proved to be a rather controversial landform. A fairly sharp ridge extends along the eastern side of the corrie and is overlain by LLS moraines. Two main views prevailed after the proposal that the feature is a pronival form was rejected. Some of the party interpreted the landform as a moraine left by a lobe of Glen More ice (in a similar situation to that of the northern end of the Larig Ghru), although others thought that it was a bedrock ridge, invoking a line of quartz clasts as supporting evidence. The general agreement was that a trench should be cut through the ridge using a JCB. Since a funicular railway is to be built, the cutting of such a ridge was not seen to be environmental vandalism.

Some of the party were reluctant to leave this ridge and the question was raised "how many academics does it take to cause a delay ?" After a considerable delay, "one" was the agreed answer.

The final stop of the trip was further along the eastern flank of the corrie at several boulder lobes. **Colin Ballantyne** explained the current thinking on such features, managing to include a reference to brandy butter running down Christmas Pudding. After that the field trip was abandoned due to hunger.

The organisers and contributors were thanked before people went their separate ways. This trip was a huge success and enjoyed by all.

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7th INTERNATIONAL CONFERENCE ON ACCELERATOR MASS SPECTROMETRY (AMS-7)

20th-24th May, 1996

This meeting, the seventh in the series of international meetings devoted to Accelerator Mass Spectrometry, was held at the Westward Look Resort in the foothills of the Santa Catalina Mountains, Tucson, Arizona. Over 250 delegates from all parts of the world met to discuss progress in the development of the AMS method, as well as new sampling techniques and important applications of AMS. The conference was organised by members of the NSF-Arizona AMS Facility in the University of Arizona, and sponsored by the Universities of Arizona and California (San Diego), the National Science Foundation, the Lawrence Livermore National Laboratory, High Voltage Engineering Europe B.V. and the National Electrostatics Corporation. It is impossible to do justice to all of the papers presented at AMS-7, but the following is an attempt to convey a flavour of this rich and varied meeting.

Quaternary scientists are perhaps most familiar with AMS in relation to ^{14}C dating, but this conference was about much more than that. Indeed, it was an eye-opener in a number of respects. The initial sessions were devoted to new AMS facilities and techniques, and included presentations on developments at Kiel, Munich, Vienna, Tsukuba, Kyoto, Sao Paulo and Buenos Aires. Progress reports on existing AMS facilities came from Arizona (Tucson), California (Lawrence Livermore) and Indiana (PRIME - Purdue) in the United States; from Erlangen, Groningen, Utrecht and Zurich, in Europe; from the ANTARES facility in Australia; from IGNS in New Zealand; from the PKUAMS facility (Beijing) and SINR minicyclotron (Shanghai) in China; and from the AMS system at the University of Tokyo in Japan. An accompanying poster session provided details of further AMS developments, with reports from other facilities in Europe, Canada and India. These presentations showed that not only is interest in AMS and, moreover, capital investment in AMS facilities, increasing world-wide, but also that a range of ions other than ^{14}C (notably ^{10}Be , ^{26}Al , ^{36}Cl , ^{41}Ca and ^{129}I) are now being routinely analysed and that these have enormous potential in environmental science, and particularly in Quaternary research.

The latter point was brought home in subsequent oral presentations and poster displays. One afternoon, for example, was devoted entirely to applications of ^{129}I and ^{36}Cl , with part of the session focusing on cosmic ray interactions in ice. Papers of Quaternary interest included the significance of ^{10}Be in ice cores (Raisbeck), solar and geomagnetic effects on ^{10}Be and ^{36}Cl concentrations in the GISP2 ice core (Finkel *et al.*), ^{36}Cl variations in Greenland ice since 1425 AD (Beer *et al.*), and ^{10}Be and dust in polar ice (Baumgartner *et al.*). Another session considered cosmic-ray variations and interactions, and included a discussion of the ^{10}Be spike at 35 ka BP, and its possible relation to a supernova explosion

(Damon *et al.*). There were, of course, several sessions specifically devoted to ^{14}C . In a series of papers on archaeological applications, such diverse topics as the dating of aboriginal rock art (Tuniz *et al.*), lime mortar in old buildings (Heinemeier *et al.*), and linen (Gove *et al.*) were explored. Elsewhere, discussion ranged from radiocarbon calibration during the last deglaciation using TIMS ^{230}Th ages of corals (Burr *et al.*), through the dating of pollen concentrates from loess-palaeosol sequences (Zhou *et al.*), to the roles of ^{13}C and ^{14}C in unravelling the global carbon budget (Francey). More technical sessions (from this delegate's perspective, at least) included Biomedical applications of AMS, Sample and target preparation, and Negative ions and ion sources.

The abstracts of the papers presented at the Tucson Meeting are contained in *Radiocarbon* (1996) volume 38 number 1. This volume also includes abstracts from two important workshops that were held immediately before and after AMS-7: one on Applications of AMS to Global Climate Change (La Jolla, California), and the other on Geological Applications of AMS (Tucson, Arizona). Many of the presentations at these workshops, for example those relating to surface exposure dating (*eg* Ivy-Ochs *et al.*), are particularly important from a Quaternary perspective, and it is good that the abstracts have been made accessible to a wider audience through publication in *Radiocarbon*. It is worth mentioning that volume 38 of *Radiocarbon* contains a second set of abstracts from the workshop in 'Secular Variations in Production Rates of Cosmogenic Nuclides on the Earth' held at Santa Fe, New Mexico earlier this year. That meeting considered the technical aspects and interpretations of cosmogenic nuclides in geomorphology (summarised by Gosse *et al.*), and again much of this material is of direct relevance to Quaternary research. The papers from the AMS-7 conference will eventually be published in *Nuclear Instruments and Methods in Physics Research*.

AMS-7 was a most stimulating and important meeting which strikingly demonstrated both the range of applications and also the enormous potential of Accelerator Mass Spectrometry. It is a technique which clearly has major implications for Quaternary science, and particularly for geochronology. It is depressing, therefore, to find the UK falling steadily behind in research in this field. Only 13 British delegates were registered for the meeting, only two papers at AMS-7 were presented by British scientists, and one of those (dealing with biomedical applications) involved analytical work using an Australian accelerator. It seems that in AMS, as in so many other areas of British science, we seem destined to become customers in the international market place, rather than world leaders in research and development.

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YOUNG RESEARCH WORKERS AWARDS 1995

Further investigation of the basal ice layers of Matanuska Glacier and Worthington Glacier, south-central Alaska

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This project was undertaken during the University of Southampton Alaska Expedition, in collaboration with Dr Jane Hart. The author's primary aim was to familiarise himself with the general appearance, sedimentology and styles of deformation associated with debris-rich basal ice layers. In addition, it was hoped that further investigation might shed light on Hart's recently proposed deforming layer/debris-rich basal ice continuum (Hart, 1995).

Two sites in particular were studied in detail, the Matanuska Glacier and the Worthington Glacier. These two Alaskan glaciers were found to differ markedly in their general glaciological characteristics.

Appearance and sedimentology

The basal ice layer of the Matanuska Glacier has been made famous by the work of Daniel Lawson (*eg* 1979). This glacier is characterised by a thick (up to 12m) basal ice layer, comprising a number of separate ice facies, subsequently admixed by intense marginal compression. In comparison, the basal ice layer at the Worthington Glacier is less well known, comprising fewer ice facies, and is usually much thinner (<1m).

On a purely visual basis, the basal ice layers of both glaciers were subdivided into three main ice facies:

1. Mostly thin (~1-2mm thick) laminae of frozen sediment. These were particularly visible when the section was viewed from a distance, but were less distinct close up.
2. Ice containing small, densely packed aggregates of fine-grained sediment (~1cm thick).
3. Relatively debris-poor ice with a lower density of larger fine-grained clay clasts up to 1cm in diameter. The clasts were predominantly angular, although some spherical examples were observed. In this facies, sediment also occurred along the crystal boundaries in places.

Sedimentological analyses of the basal ice layers were performed at both sites, particularly rigorously at Matanuska Glacier. Many sites at the Matanuska Glacier showed a decrease in debris concentration upwards through the basal ice layer, whilst some sites displayed a reduction in clast fabric strength with height. These results suggest that strain rates increase upwards through the basal ice layer (*cf* Hart, 1995).

Styles of deformation

At Worthington Glacier, a sequence abutting a bedrock knoll displayed evidence of strong marginal compression, with recumbent folds being present. The sequence at this site was also split by a number of listric faults, and showed evidence of intercalation with the overlying debris-poor glacier ice.

The situation at Matanuska Glacier was rather more complex, reflecting a more varied suite of deformation styles. Most of the sequences examined showed a high degree of stacking and admixing of all the different basal ice facies and of glacier ice. Folds, faults and boudinaged sections were common, suggesting that the debris-poor material was acting as the more competent material in all cases.

A number of often steeply-dipping debris bands were also observed at the latter site. These were composed of a variety of sediment types ranging from frozen laminations of fine-grained sediment, to cobble-sized clasts. These features may themselves be indicative of marginal deformation, possibly representing the attenuation of sediment entrained in basal cavities (*cf* Knight *et al.*, 1994).

Many thanks are due to the QRA, whose generous donation assisted in financing the expedition.

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Altitudinal variation of stable isotopes over an outlet glacier, Ellesmere Island

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The aim of this project was to test the fractionation with altitude of stable isotopes over an outlet glacier from an Arctic ice cap. Investigations of the Greenland Ice Sheet have demonstrated a linear fractionation of oxygen and hydrogen isotopes with altitude (Dansgaard *et al.*, 1973). Similar changes with

altitude have been assumed for ice caps but this has not been rigorously tested at this scale. Snow samples were taken from snow pits dug in an altitudinal transect along the Van Royen Glacier, an outlet from an un-named ice cap in northern Ellesmere Island (80°52'N, 83°40'W). Co-isotopic analysis of $\delta^{18}\text{O}$ and δD was carried out at the National Isotope Geosciences Laboratory, Nottingham.

The profiles of isotopic composition with depth are remarkably similar at each pit investigated. $\delta^{18}\text{O}$ and δD values increase with depth from a minimum close to the snow surface. There is a particularly marked change (10-12% in $\delta^{18}\text{O}$ and 80-100% in δD) at approximately one quarter depth in each pit. A co-isotopic plot of the samples shows that they lie on a 'precipitation slope' (slope = 8.2, $R^2 = 0.99$) implying that the isotopes have not been subjected to significant post-depositional fractionation (Souchez and Jouzel, 1984).

A depth-weighted mean isotopic composition can be calculated for each pit. A plot of the mean isotopic composition against altitude shows no clear trend. In other words, there is apparently not a progressive change in isotopic values of snow with altitude on this ice cap. The most likely explanation for the lack of fractionation is that the snow has been derived from a single level of condensation and thus forms a relatively homogeneous cover on the ice cap.

There are at least two possible explanations for the prominent change in isotopic values recorded in all of the pits: (i) the first snow to fall on the glacier did so under (relatively) high temperatures whilst later snowfall occurred under lower precipitation temperatures, or (ii) there was a change in precipitation source (and therefore initial isotopic values), possibly related to an increase in sea ice extent in the Arctic Ocean over the accumulation season. Thus, there would be less moisture available to air masses passing over the ocean and they would become increasingly depleted in ^{16}O .

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REVIEWS

ISLAND BRITAIN: A QUATERNARY PERSPECTIVE

Edited by R.C. Preece
Geological Society of London
ISBN 1-897799-40-3 1995. 280pp,
Hardback £56 (£29 to Fellows of the Geological Society)

The title of this book has a certain eye-catching appeal and holds the promise of an entertaining read as well as a stimulating reference source. Indeed this collection of papers is both readable and informative, drawing on a host of geological and biological techniques to review Britain's changing status as an island during the Quaternary.

The scene is set by **Funnell**, who traces the history of the North Sea region back to the Mid-Pliocene - a time when Britain was surrounded by warm seas. This isolation was short-lived; a fall in global sea level and a change in fluvial régime during the Late Pliocene resulted in the formation of a large prograding delta, which pushed coastlines far into the present offshore area. These conditions persisted for much of the Early Pleistocene. **Gibbard** focuses on an event which had a dramatic effect on the palaeogeography of the region during the Middle Pleistocene: the formation of the Straits of Dover. He assigns the initial breaching to the Anglian Stage, showing how meltwaters from a large ice-dammed lake spilled over the Weald-Artois anticline to form a passage through the English Channel. **Bridgland and D'Olier** examine the impact of this event on fluvial evolution during subsequent low sea-level stands, paying particular attention to the Thames and the Rhine. Both rivers are believed to have become confluent with the Lobourg River of the Channel, although the resulting drainage direction remains uncertain. **Keen**, in contrast, considers the evidence for late Middle and Late Pleistocene high sea-level stands, drawing on TL and Uranium-series data from the English Channel to identify three phases of isolation, tentatively correlated with oxygen isotope stages 9, 7 and 5.

The emphasis in many of the remaining contributions is on fossil remains, particularly their potential for determining periods of insularity or connection. **Stuart** concentrates on vertebrate remains, comparing the terrestrial faunas of Britain with those of Ireland and the continent. He notes that the Irish Holocene and Midlandian (last cold stage) faunas are more impoverished than those of other regions, indicating prolonged isolation from Britain. **Sutcliffe** also focuses on vertebrate data, concentrating on mammalian evidence from the last 250,000 years.

Bennett examines the extent to which insularity can be determined from plant remains, looking at the dispersal ranges of trees and shrubs which are native to

the British Isles to shed light on the Quaternary record. The results are illuminating; a sea passage like the English Channel (which is presently 34km at its narrowest) is shown to have no effect in controlling the dispersal potential of most of the plants considered, the vast majority of which have the capacity to spread over 10s to 100s of kilometres. It follows that pollen and plant macrofossilss have little potential for determining Pleistocene isolations.

Coxon and Waldren also examine floristic remains, focusing on the palaeobotanical record of Ireland's temperate stages. A remarkable characteristic of these floras is the repeated occurrence of exotic species (*eg* *amphi-Atlantic* species), whose native habitats occur in southern and central Europe. The authors show how these elements could have been introduced from long-distance sources during low sea-level stands, although migration from local refugia is considered to be a more realistic possibility. **Meijer and Preece** also assess migratory behaviour in a review of the malacological evidence for insularity. An intriguing aspect of their data is the poor representation of southern (Lusitanian) species in the Holsteinian marine faunas of the North Sea region. This tends to imply that the passageway through the Dover Straits was restricted at this time.

Lister uses the example of the dwarfing of the red deer on Jersey during the Ipswichian to highlight the dramatic effect which insularity can have on small island communities. This paper provides an inspiring example of how bio-, litho- and chronostratigraphical data can be combined to examine phenotypic phenomena.

The final focus of the volume is directed towards understanding the environmental determinants of insularity, particularly the factors which influence landbridge formation. The contribution of **Devoy** addresses this issue explicitly, providing a comprehensive review of the major factors and controls. **Wingfield** goes one step further, using data from the Irish offshore area to construct a model of sea-level change for this region during the end-Pleistocene to Holocene transition. This is used to predict the existence of two landbridges after 11.35 ka BP, first between Britain and Ireland and later to the Isle of Man.

In spite of the breadth of material covered in this volume, the papers nevertheless adhere closely to the underlying themes, binding the book into a coherent whole. For this the editor is to be congratulated. There are, however, one or two areas where I felt the volume would have been improved: more discussion on the impact of insularity on human activity would have been nice. Notwithstanding this, I have no hesitation in thoroughly recommending it. At only £29 for QRA members it is excellent value for money.

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**GEOLOGY OF THE COUNTRY AROUND HITCHIN.
MEMOIR FOR 1:50,000 GEOLOGICAL SHEET 221
(ENGLAND AND WALES)**

**P.M. Hopson, D.T. Aldiss and A. Smith
British Geological Survey, HMSO, London
ISBN 0-11-884518-7 1996. 153pp, Softback £55.00**

Following publication of the excellent 1:50,000 solid and drift map of sheet 221 (Hitchin) in 1995, the BGS has now completed the 'double' by producing the first-ever memoir for this sheet. The memoir, like the map, demonstrates the very high production standards currently adopted by Keyworth. For many decades the absence of any recent survey in the area of sheet 221 has been a severe limitation upon geological endeavour in both this area and the wider region. With the exception of some minor overlapping surveys from neighbouring sheets, the last survey was accomplished in 1884. Prior to recent work, no explanatory memoir had been published apart from that of Whitaker *et al.* (1878), which covered part of the area of sheet 221. Thus the new map and the memoir are very welcome indeed.

The largest chapter describes and evaluates the Quaternary deposits in stratigraphic order. Of much interest is the Early Pleistocene Letchworth Gravel, first recognised during the survey and described in the memoir. It is highly quartzose, having petrographic affinities with gravels of Midlands provenance, and was apparently deposited by a tributary of the pre-Anglian Thames.

The *pièce de résistance* of the Quaternary chapter is the description of the extensive Anglian sediments and structures of the area. Rafts, principally of Chalk Rock, which occur within the till south of Royston, are convincingly described and interpreted in terms of Hopson's (1995) mechanism for their emplacement. Buried channels, frequent over the whole sheet, are described, classified into six types and their origins discussed. Much effort has been put into elucidating the complex geology of the Hitchin-Stevenage Gap. Purpose-drilled and other boreholes have been evaluated to interpret this difficult ice-marginal palaeoenvironment dominated by a complex of buried valleys. Supportive maps, photographs, tables and sections of a high standard help to make this a fascinating and illuminating part of the chapter. Both in the text (pages 93-99) and in sections (Figures 25a and 25b) a lithostratigraphy is constructed, based largely upon recognition of four marker units of till. Nagging worries do occur to the reader, though, and these are not alleviated when the more detailed Technical Reports for the component 1:10,000 sheets are consulted. The basis upon which sediments are equated from one borehole or exposure to another is not made clear. If no petrographic analyses have been performed, it is difficult to demonstrate the equivalence of beds in exposures or boreholes separated by 'dead' ground. True, when the boreholes and

exposures are close together (eg Figure 26), equivalence, albeit based upon spatial relations, is more convincing. The main worries are about extrapolating, apparently without supporting petrographic evidence, from the Hitchin-Stevenage Gap, to other areas of sheet 221 and, more particularly, to the Vale of St Albans on the neighbouring Hertford sheet, as proposed in Table 12. Here, the authors have sought to relate the Hitchin-Stevenage Gap sequence to Gibbard's (1977) stratigraphy for the Vale of St Albans. In this respect it is unfortunate that Bridgland's (1994) alternative scenario for the Vale of St Albans was not available for consideration. The glacial history of the Hitchin-Stevenage Gap is excellently displayed in Figure 27 by an evolving sequence of maps based upon the proposed stratigraphic sequence.

Description of the Hoxnian deposits brings together details of the many sites of this age on the Hitchin sheet. Corey's Mill, Fisher's Green, Gunnell's Wood Road, Maydencroft Manor, Oughtonhead Lane and Todd's Green, all from the Hitchin-Stevenage Gap, are clearly described and evaluated. Although post-Hoxnian deposits are considered in lesser detail, each of the deposits identified by the survey is clearly described. The section is concluded by an interesting note on Palaeolithic finds in the district by John Wymer.

Despite minor reservations, the memoir is a most welcome addition to the literature of the district. Peter Hopson and his co-authors have produced a volume of which they may be justifiably proud. The enormous advances in the modern BGS 1:50,000 memoirs become so readily apparent when they are compared with, for example, the extant, but out of print, 1924 memoir for the Hertford sheet. However, when beer was 2d a pint, the Hertford memoir (1s 6d) would have been equivalent to 9 pints. Today you would need to forgo 30 pints to afford the Hitchin memoir, but it is still good value.

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MODERN POLLEN RAIN, VEGETATION AND CLIMATE IN LOWLAND EAST JAVA, INDONESIA

Kristina R.M. Beuning
Balkema, Rotterdam

ISSN 0168-6151, ISBN 90-5140-629-8 1996. 55pp, 49pl, Hardback £46

This compact, neatly organised, monograph in the Modern Quaternary Research in Southeast Asia series investigates how well modern pollen rain in lowland East Javan lakes represents the existing vegetation, if a local or regional signal is detectable, and if the pollen content varies under different moisture régimes. The aims (p. 2) are not clearly put. It examines samples from basin environments as a possible precursor to fossil pollen work, in an area where the natural vegetation cover has not been described, to assess if they can be used to detect the causes of past environmental variations. It concludes that the data will be of more use in tracing the impact of people on vegetation than climatic change. Construction of transfer functions relating climate to vegetation is not on. Only where there has been fairly recent occupancy of an area, eg south-eastern Australia (cf Kershaw *et al.*, 1994), can one go further through examining samples from pre-occupation levels at a variety of sites. This reviewer disagrees that more information on the relationship between the pollen spectra and the surrounding vegetation is necessary solely from the lowlands. It is true that wind pollinated and locally growing taxa dominate highland pollen records, but there is a need to look at the minor taxa to add to the detail of vegetation reconstruction.

The research strategy is poor: too much is attempted. To tackle the questions posed requires extensive study of local and regional vegetation, collection of modern reference pollen from correctly identified plants, and access to a large ancillary reference collection covering the wider area. Examination of the vegetation is superficial and there is no indication if flowering specimens were collected to build a reference collection or that a larger pollen reference collection was examined. Therefore most of the taxa distinguished, described, and illustrated, by quite good microphotographs, remain unidentified, although it is possible to put names to a fair number of them, eg Pl. 22B shows *Quercus*, and Pl. 38C *Pteris vittata*. However, *Castanopsis/Lithocarpus* and *Macaranga* have been allotted several 'Unknown' numbers and are illustrated on several plates. The few positive identifications seem to be mainly correct.

The over-concise introduction shows insufficient background reading on the use of modern analogues to reconstruct past vegetation conditions and Javan, Indonesian, and tropical palynology generally. The writer could have mentioned Semah (1982, 1984a, 1984b) and Tokunaga *et al.* (1985) on fossil lowland Javanese pollen, Thanikaimoni (1983) on modern pollen samples, and Caratini and Tissot (1985) on modern and fossil pollen from the Mahakam Delta of

Kalimantan. The list of taxa they identified could have helped with her identification problems.

The assertion that limited palaeoecological research has been carried out in the lowland tropics because ecological information about the vegetation is unavailable (p. 2) is not borne out by the facts; there is pollen literature from the lowland tropics of all continents, plus Oceania, from areas where there is often limited ecological information. If we think it will contain pollen, we sample it!

Samples were taken from 10 lakes/reservoirs at altitudes which seem to range from 110 to 1,290m (all lowland?), but not all altitudes are recorded, and various moisture régimes. The surrounding vegetation had been disturbed to a greater or lesser degree. Most samples were from the top metre of short cores (1-5 per site), therefore the fluid, true, surface material may have been lost. Lake water samples were not collected for comparison, and we are not told what type of borer was used. However, counts were large (550-620 per sample) and microspheres were added to determine pollen concentrations, but it is not clear what magnification was used in routine counts: it may have been as low as 198x! Lake-specific 'unknowns' were identified, grouped, and the lakes were classified as from wet, dry, or very dry moisture régimes. Within-lake variability of pollen deposition was tested using Chi-squared.

This work shows some originality: an attempt was made to estimate the source area of pollen using graphs of pollen deposition for relatively light pollen types, and the grain size of the inorganic sediment fraction was analysed using a Labtec-1000- particle analyser with a backscatter laser, but we are not told if grain size influences pollen content. Raw sediment was investigated on a palaeofacies basis using a petrographic microscope, but Van Wavern (1989), not referred to, did something similar with sea-bed samples. We do now have more pollen concentration figures that we had before.

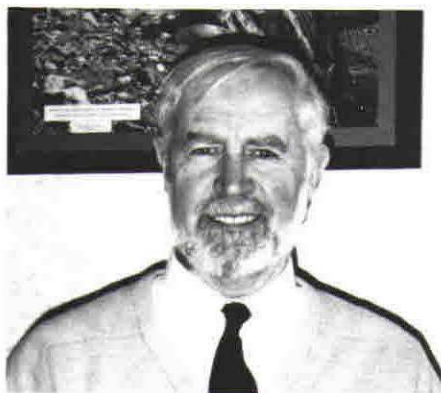
Clearly there are rough edges, but it is pioneer work, and rough edges are part and parcel of pioneer attempts. When the 'unknowns' are properly identified the microphotographs will be of use to other palynologists as were those in Huang (1972, 1981). Problems of identification are the bane of tropical palynology.

Considerable effort has been put into producing this volume, especially the microphotographs. It is a pity that more thought was not put into devising the research strategy. However, the book is of considerable value for the specialist, and a learning tool for others. Beuning sought to learn the hard way.

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PROFESSOR EDWARD DERBYSHIRE

Professor Edward Derbyshire, of the Quaternary Research Centre at Royal Holloway (University of London), has been elected to the Chairmanship of the Scientific Board of the International Geological Correlation Programme (IGCP) for the period 1996-1998. The IGCP was founded in 1972 in order to facilitate collaboration between earth scientists around the world working on problems vital to the study of the Earth and its resources; promote exchange of ideas, information and techniques; assist in the training of geoscientists; and to enhance the quality control of global scientific information. This well-established international programme is managed jointly by UNESCO and the International Union of Geological Sciences (IUGS). It is widely regarded as the most successful programme open to scientists world-wide in the field of solid earth sciences, and UNESCO regards it as one of its most successful ventures. Participation in IGCP projects is open to any geoscientist from any country of the world. Selection and progress assessment of projects is conducted by peer review involving independent scientists and the IGCP Scientific Board. The IGCP is not primarily a funding agency, but small sums are allocated (average \$6,000 for each year of operation), as 'seed money', to the leaders of accepted IGCP projects (which normally run for up to five years) to assist with meetings rather than research or publications. Given IGCP recognition, however, most projects prove successful in obtaining additional financial support from national organisations. Participating nations number 155, and news of IGCP activity is regularly reported in its official journal, *Episodes*. Projects in Quaternary and applied geology are prominent elements within IGCP. As Chairman of the Scientific Board, Ed Derbyshire will have the responsibility for ensuring that links between IGCP and other earth-science bodies, already well established, are further strengthened and increased.

ABSTRACT

FOOD FOR THOUGHT: LATE MAGDALENIAN CHRONOLOGY AND FAUNAL EXPLOITATION IN THE NORTH-WESTERN ARDENNES

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ABSTRACT

This dissertation examines certain aspects of the Belgian archaeological record during the Devensian late-glacial. It is geographically centred on the north-western Ardennes and has two main themes.

The first is a re-evaluation of the known chronology and archaeology for this region during the late-glacial. The typology and technology of archaeological material traditionally identified as *Magdalenian*, *Creswellian*, *Tjongerian* and *Ahrensburgian* from the Belgian sites is discussed. Alongside this, recent radiocarbon dates obtained *via* the Oxford AMS system during the course of research are presented. It is concluded that there are major problems of definition and recognition surrounding much of the Belgian late-glacial archaeological database and a revised chronology for the human settlement of this region during the late-glacial is proposed.

The second theme is an examination of a series of supposedly late-glacial faunal assemblages from five cave sites in the north-western Ardennes, namely the Trou de Chaleux, the Trou des Nutons at Furfooz, the Trou du Frontal at Furfooz, the Grotte du Coloptère and the Grotte de Sy Verlaine. All of these sites have yielded late Magdalenian archaeological finds, and the prime objective of the study of the faunal assemblages is to identify direct evidence for the human modification of animal bone, and investigate butchery practice during the late-glacial. The study reveals detailed evidence for the latter, but also certain bars to the interpretation of each of the assemblages in question which are discussed in detail. This dissertation concludes with an overview of the results and interpretations presented in the text. The final pages include a tentative exploration of the notion of *ethnicity*, and how this concept may be relevant to the interpretation of butchery practice and Late Palaeolithic society.

LETTER TO THE EDITOR

RELICT ICE-MOUNDS IN WEST WALES - PINGOS OR PALSAS?

I noticed with interest that the problem of the 'ice-mounds' in West Wales is once again under investigation after a lapse of more than twenty years.

In issue 77 of the *Quaternary Newsletter* Stephen Gurney attempted to explain these features in the Cledlyn Valley as mineral palsas similar in origin to those north of Quebec at present under investigation. These are formed on marine silty-sand by cryosuction horizontally rather than by artesian pressure from below a frozen bed under conditions of discontinuous permafrost. As a source of the unstratified clay-silt in the basins he envisages an ice-dammed lake similar to that in the Teifi basin which was blocked by the Irish Sea ice sheet at the coast. However there is no evidence of such a lake in the Cledlyn Valley. Varves outcrop nowhere; only a bore put down to bedrock between two of the deep basins (eg U and W) would finally prove its absence. Varves in the Teifi Valley, upstream of Cardigan, are beautifully stratified; the unstratified clay-silt in the Cledlyn occurs only in the pingo basins, whether shallow or deep (>10.3m). It has been derived from the matrix of the till (slope deposits) of the valley sides, ultimately from the mudstone bedrock. Stephen also mapped a little gravel pit. Small patches of heavily stained gravels without morphology, occur scattered over the Mynydd Bach (>300m), the watershed north-west and between the Cledlyn and the coast. These strongly resemble the patch in the Cledlyn. They contain scattered igneous erratics from North Wales, also a very rare flint - one was found in the nearby Cletwr Valley.

Although these 'ice-mounds' have been identified as open-system (hydraulic) pingos, one important problem could not satisfactorily be explained, *ie* the method of collapse. The sorting and lack of stratification of the clay-silt in the basins is quite out of keeping with both theories, neither pingo nor palsa. In both cases, the coarse material of the roof and ramparts is entirely missing in the basins. Where has it gone?

A visit in 1972 to an hydraulic pingo in an advanced state of collapse near Dawson City with Owen Hughes, during an international geological excursion, was exciting. All features appeared to be exactly comparable with the Cledlyn basins - the position at the base of a valley side forming a U-shaped rampart while absent on the hill slope behind, level-topped but much steeper and very much higher than the Welsh ramparts. The whole was heavily forested, the pond inside also heavily vegetated. Great slips from the inner rampart face were

sliding into the pond, carrying trees at drunken angles and leaving behind exposures where the dull gleam of ice showed in the depths. Obviously the coarser material and related vegetation must occur in the pond depths. It is entirely missing in the Welsh examples investigated.

Albert Pissart first identified the 'viviers' of the Haute Fagné as open-system pingos, but after further field work became convinced that they had originated as mineral palsas. His three reasons for change of opinion were: 1. the impervious nature of the bedrock; 2. the lack of relief on the plateau; 3. their high density.

To apply these points to the Cledlyn basins: (1) The impervious nature of the bedrock. The mudstone bedrock is highly permeable as the engineers building the Nant-y-Moch dams found to their cost in the frequent rockfalls and numerous accidents resulting from its weakness. (2) Relief is no problem in the steep-sided Cledlyn Valley. (3) Density is purely a matter of time (Owen Hughes, pers. comm.). Many of the basins occur in sequence, each higher basin partially destroying the ramparts of the previous pingo. Probably this development upslope took place as the water supply forcing its way up through some zone of weakness in the overlying frozen bed, became blocked.

Limited resources made it impossible to do other than record the existence of a great number of similar basins in Wales. These await the detailed investigation of a later generation of geomorphologists. Until then, our best guess seems to be that they are some form of hydraulic pingo. The problem awaits solution.

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NOTICES

1. PROPOSAL FOR NEW INQUA COMMISSION ON QUATERNARY MINERAL DEPOSITS

The Russian INQUA Committee made a suggestion at the XIV INQUA Congress in Berlin for the formulation of a new INQUA commission on Quaternary Mineral Deposits. This proposition has been supported by many of the other national committees.

This new commission has been proposed with a view to understanding the formation, spatial and temporal distribution of Quaternary mineral deposits, including placers of gold, diamond, tin, titanium, rare metals and other precious stones; construction materials (sand, gravel, clay); salts; fertilisers (sapropels, peat); water; gas hydrates. The commission would also aim to consider the often devastating environmental impacts associated with the exploitation of such minerals and the development of appropriate management and rehabilitation measures. The new commission would complement rather than conflict with existing INQUA commissions, and would have as its main aim the development of new strategies in the evaluation and exploitation of Quaternary mineral deposits designed to minimise detrimental environmental impacts.

Since new INQUA commissions can only be adopted by the General Assembly, it is proposed to create an *ad hoc* committee or working group for the 1995-1999 inter-congress period with a view to adoption at the next INQUA Congress. It is likely that the working group will be involved in the organisation of the XI International Symposium on *Placers and Weathered Rock Mineral Deposits* to be held in Moscow in 1997.

Anybody interested in participating in the activities of this working group from the UK should contact:

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e-mail: shev@igem.msk.su

2. IGCP LATE QUATERNARY COASTAL RECORDS OF RAPID CHANGE: APPLICATION OF PRESENT AND FUTURE CONDITIONS

Tidal amplitude change working group - leader Dr A.C. Hinton, U.K.

The tidal working group was set up as a result of papers given at the International Meetings of IGCP 367 which indicated a need for greater understanding of the tidal contribution to the sea-level change record.

Aims and objectives of the tidal working group:

1. Establish a bibliographic database comprising both direct studies of tidal changes and others where information on tidal heights has been obtained (indirectly) as a result of research. The timescale for this database will be as defined by the IGCP 367 project title.
2. Obtain a reference list of indicators of tidal levels from geomorphological, sedimentological, biological, archaeological, etc. data. It is intended that this should be published as a final report of IGCP 367.
3. Following from the bibliographic database, information on tidal height changes will also be synthesised on a regional basis, where sufficient data are available, to obtain a picture of tidal development with coastal changes in each area.
4. Where tidal changes of varying magnitude and/or direction are identified by employment of different methods (*eg* stratigraphic *versus* modelling), the causes of these differences will be examined in order to: (a) improve techniques; (b) obtain an accurate record of tidal changes.
5. A list of those with an interest in the field, including postal addresses, contact phone and fax numbers and e-mail addresses, together with information on the techniques employed by workers in the field and the geographical areas in which they are carrying out research, will also be compiled.

Although the list above represents the primary aims of the working group, anyone with an interest in the topic (whether actively involved in research on tidal changes or not) is encouraged to contact me, preferably by e-mail.

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3. ICE AND SNOW DATABASE ON WWW

A new database containing over 25,000 references on glaciology and related subjects (including ice physics and chemistry, frozen-ground engineering, glacial geology, remote sensing of ice sheets and sea ice) can now be accessed free-of-charge at:

<http://www.muscat.co.uk/ccdplspri/wdccc.html>

Further information and copies of most of the items covered can be obtained for a small fee from:

Oliver Merrington, WDC-C Manager

Scott Polar Research Institute, Lensfield Road, Cambridge, CB2 1ER

Tel: 01223-336556; Fax: 01223-336549

e-mail: ojml2@cam.ac.uk (Source: Science International)

4. THE EUROPEAN POLLEN MONITORING PROGRAMME

The European Pollen Monitoring Programme is a new INQUA working group within the Holocene Commission. The EPMP was launched at a meeting in Finland in July 1996. The aim of the Programme is to build up a body of data about modern pollen influx values for the major tree species and the ecologically significant shrub and herb species throughout Europe. It is intended that these data will be used by palaeoecologists to help achieve increasing accuracy in the reconstruction of past vegetation communities. Dr Sheila Hicks from the University of Oulu, Finland, is co-ordinating the Programme.

Twenty seven delegates from 15 different countries, ranging from Ireland in the north to Greece in the south, were present at the initial meeting. Paper and poster sessions dealt with current work on the monitoring of modern pollen rain. Field visits were made to sites in Kuusamo (eastern Finland) and to the Baltic island of Hailu where Sheila Hicks has a long and interesting record of modern pollen influx into 'Tauber style' pollen traps. On the final day of the meeting, delegates agreed a protocol for future pollen monitoring using traps which will be placed along transects that cross treelines throughout Europe. It is intended to monitor initially for three years in a uniform way and to enter the results into a pollen monitoring database which ultimately will be linked to the European Pollen Database.

If anyone in Great Britain is interested in joining the EPMP trapping network and would like more details contact either:

**Heather Tinsley or
112 Weston Road
Long Ashton
Bristol
BS18 9BZ**

**Heather Pardoe
Department of Botany
National Museums and Galleries of Wales
Cathays Park
Cardiff**

QUATERNARY RESEARCH ASSOCIATION

The Quaternary Research Association is an organisation comprising archaeologists, botanists, civil engineers, geographers, geologists, soil scientists, zoologists and others interested in research into the problems of the Quaternary. The majority of members reside in Great Britain, but membership also extends to most European countries, North America, Africa, Asia and Australasia. Membership (currently c. 1200) is open to all interested in the objectives of the Association. The annual subscription is £15 with reduced rates (£5) for students and unwaged members and an Institutional rate of £25.

The main meetings of the Association are the Annual Field Meeting, usually lasting 3 or 4 days, in April, and a 1 or 2 day Discussion Meeting at the beginning of January. Additionally, there are Short Field Meetings in May and/or September, while Short Study Courses on techniques used in Quaternary work are also occasionally held. The publications of the Association are the *Quaternary Newsletter* issued with the Association's *Circular* in February, June and October; the *Journal of Quaternary Science* published in association with Wiley, with six issues a year; the monograph series *Quaternary Proceedings* also in association with Wiley, the Field Guides Series and the Technical Guide Series.

The Association is run by an Executive Committee elected at an Annual General Meeting held during the April Field Meeting. The current officers of the Association are:

President: *Professor F. Oldfield*, PAGES Core Project Office, Barenplatz 2, CH-3011 Bern, Switzerland

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October 1996 No. 80

Contents

Page

- 1 **EDITORIAL**
- 2 **ARTICLES**
- 3 The Environmental History of a Late-Glacial Site at Kråkenes, Western Norway, Based on Cladoceran Microfossil Assemblages: Preliminary Results and Interpretation *C. Duigan*
- 10 An Anglian Till at Long Hanborough, Oxfordshire? *J. Coe*
- 17 The Quaternary Record of Kent's Cavern - A Brief Reminder and Update *A. Straw*
- 26 **METHODS**
- A Modified Version of a Pollen Preparation Sieve *T.M. Mighall*
- 28 **REPORTS**
- 28 Report of the UCC/Iceland '150' Expedition to North-East Iceland
- 32 The Quaternary of the Lower Reaches of the Thames: Short Field Meeting
- 36 Perspectives on the Holocene Environments of Prehistoric Britain: Annual Discussion Meeting, University of Sheffield
- 42 The Fifth BGRG Subglacial Processes Working Group Meeting: Isle of Man
- 44 Postgraduate Palaeoecology Conference: Godwin Institute for Quaternary Research, Department of Zoology, University of Cambridge
- 46 Report on the 1996 QRA Field Meeting to the Cairngorm Mountains, Scotland
- 50 7th International Conference on Accelerator Mass Spectrometry (AMS-7)
- 52 Young Research Workers Awards 1995
- 55 **REVIEWS**
- 55 Island Britain: A Quaternary Perspective, edited by *R.C. Preece*
- 57 Geology of the Country Around Hitchin. Memoir for 1:50,000 Geological Sheet 221 (England and Wales) by *P.M. Hopson, D.T. Aldiss and A. Smith*
- 59 Modern Pollen Rain, Vegetation and Climate in Lowland East Java, Indonesia, by *K.R.M. Beuning*
- 62 **NEWS** Professor Edward Derbyshire
- 63 **ABSTRACT**
- Food for Thought: Late Magdalenian Chronology and Faunal Exploitation in the North-Western Ardennes *Ruth Charles*
- 64 **LETTER TO THE EDITOR**
- 64 Relict Ice-Mounds in West Wales - Pingos or Palsas? *S. Watson*
- 66 **NOTICES**

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