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Quaternary Newsletter is issued in February, June and October. Contributions comprising articles, reviews, notices of forthcoming meetings, news of personal and joint research projects, etc. are invited. They should be sent to the Quaternary Research Association Newsletter Editor. Closing dates for submission of copy (news, notices, reports etc.) for the relevant numbers are 1st January, 1st May and 1st September. Articles should be submitted well in advance of these dates. The publication of articles is expedited if manuscripts are submitted both as hard copy and on floppy disc. The preferred type for the latter is 3.5" floppy disc in Apple Macintosh format, but IBM PC compatible formats are also acceptable.

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COVER PHOTOGRAPH:
Cranium of a polar bear (*Ursus maritimus*) from Reindeer Cave, Assynt. An AMS ^{14}C date of *c.* 18,900 BP suggests that the animal died around the time of the Last Glacial Maximum. This is the first record of the species from Scotland - see article by Andrew Kitchener and Clive Bonsall in this issue (© National Museums of Scotland).

ARTICLES

AMS RADIOCARBON DATES FOR SOME EXTINCT SCOTTISH MAMMALS

Andrew C. Kitchener and Clive Bonsall

Introduction

Compared with some other regions of Britain, relatively few remains of Pleistocene and early Holocene mammals have been found in Scotland owing to poor conditions for the preservation of bone created by acid soils, extensive glaciation, a lack of limestone caves (Delair, 1969; Stuart, 1982; Sutcliffe, 1985; Andrews, 1990) and also, perhaps, limited research. Where remains have been found the contexts of the specimens are often poorly documented, many being recovered during drainage operations in the late Eighteenth and Nineteenth centuries. There is a clear need for direct radiocarbon dating of these specimens in order to elucidate the temporal distribution of each species (Delair, 1969). Some species have been recorded fairly commonly (at up to forty locations) including aurochs (*Bos primigenius*), red deer (*Cervus elaphus*), moose (*Alces alces*), and reindeer (*Rangifer tarandus*), but most are known from fewer than ten sites including arctic fox (*Alopex lagopus*), brown bear (*Ursus arctos*), lynx (*Lynx lynx*), woolly mammoth (*Mammuthus primigenius*), woolly rhinoceros (*Coelodonta antiquitatis*), wild horse (*Equus ferus*), giant deer (*Megaloceros giganteus*), beaver (*Castor fiber*), collared lemming (*Dicrostonyx torquatus*), and the northern and narrow-skulled voles (*Microtus oeconomus* and *M. gregalis*) (Ritchie, 1920; Lawson, 1995; Kitchener, unpubl.). Wolf (*Canis lupus*) and wild pig (*Sus scrofa*) were also present in the late Quaternary fauna, but the number of Scottish localities where these species have been found is uncertain owing to the problems of distinguishing between wild and domesticated forms (Ritchie, 1920; Kitchener, unpubl.).

Many of these specimens are in the collections of the National Museums of Scotland and have been acquired either directly from the finder or indirectly through the closure or rationalisation of museum collections elsewhere in Scotland. We report here AMS radiocarbon dates for specimens of bear, lynx, wild horse, moose, reindeer and beaver from various localities in Scotland (Figure 1), all of which are in the NMS collections. Dates for other species will be reported subsequently. The AMS dates are given in Table 1.

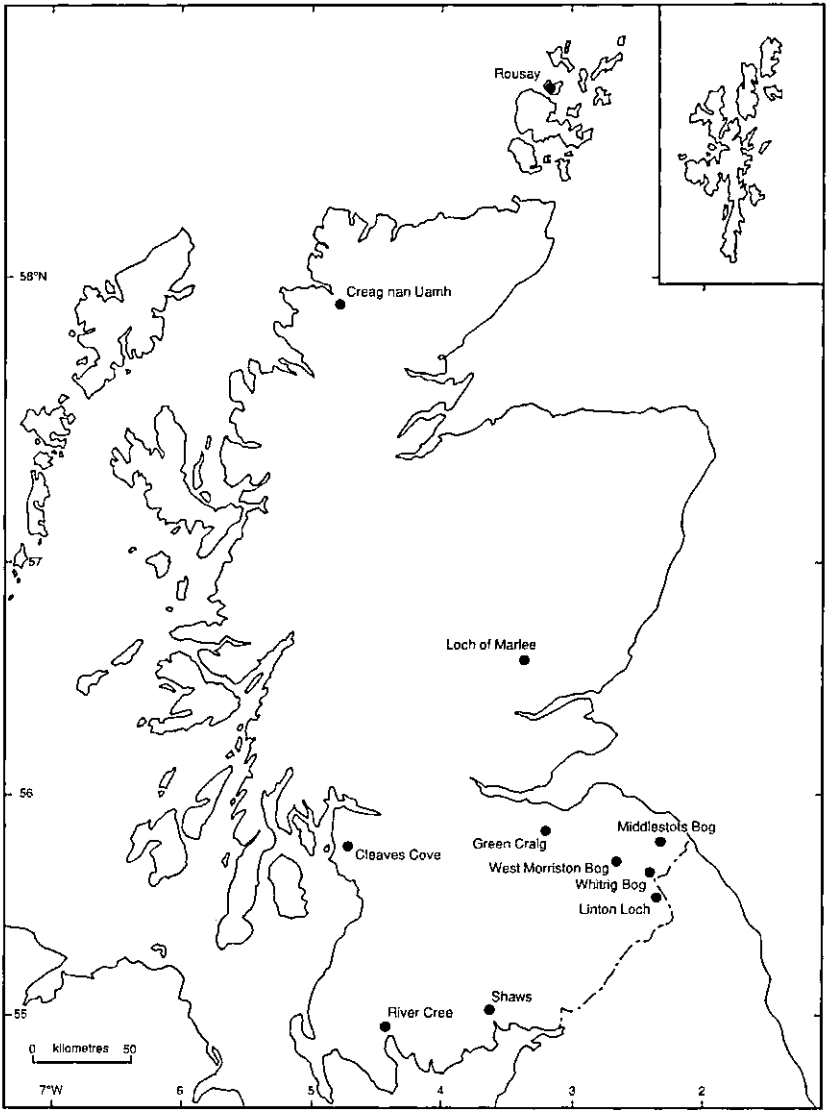

Figure 1. Sites of mammalian remains with AMS ^{14}C dates mentioned in the text.

Brown bear, *Ursus arctos*

Two specimens of brown bear were available for radiocarbon dating:

1. A complete skull was found in a peat bog at Shaws, Dumfriesshire in the mid-Nineteenth Century (Smith, 1870; 1879; Harting, 1880). It was donated to the National Museum of Antiquities, Edinburgh in 1879 (Smith, 1879), but was subsequently transferred to the Department of Natural History, NMS (now Geology and Zoology) (register no. NMSZ 1993.160.9).

2. The other specimen is a cranium found during excavations in the inner chamber of Reindeer Cave, Assynt, one of a series of caves on the south side of the Allt nan Uamh Valley to the south-east of Inchnadamph, known as the Creag nan Uamh Caves or Inchnadamph Caves (register no. NMSZ 1959.33) (Callander *et al.*, 1927). This is one of the few limestone cave systems in Scotland where abundant mammalian skeletal remains have been recovered (Lawson, 1981). The only other radiocarbon date for Scottish brown bear – 2,673 ± 54 BP (BM-724; Lawson 1995) – comes from another cave in this valley.

The Shaws skull was dated to *c.* 7,600 BP (Table 1). Brown bears may not have become extinct in Britain until the Tenth Century AD (Harting, 1880; Ritchie, 1920), so that this record from the early Holocene is not exceptional. However, the Creag nan Uamh cranium has a radiocarbon age of *c.* 18,900 BP, at which date the Late Devensian ice-sheet glaciation was probably close to its maximum extent. Although there is evidence that the highest mountains in the Assynt area stood above the ice sheet as nunataks (Lawson, 1995), it seems inconceivable that a brown bear would have survived in this glacial environment. It is probable that the cranium was misidentified; further examination suggests that it is from a polar bear (*Ursus maritimus*), as indicated by the long, flat sagittal region, the shape of the occipital crest and the relatively large occipital condyles compared with brown bear skulls. However, the teeth and facial region of the skull, which would have allowed precise identification, are absent.

A number of problems follow from this interpretation. Modern polar bears feed mainly on marine food, primarily seals, although they also eat terrestrial foods such as grass and reindeer. Olsson (1980) reports $\delta^{13}C$ ratios in bones of recent polar bears from eastern Greenland and Spitsbergen in the range -14.5‰ to -16.2‰, consistent with a predominantly marine diet. The Reindeer Cave specimen, on the other hand, has a $\delta^{13}C$ ratio of -21.0‰ which is very similar to that of the brown bear from Shaws ($\delta^{13}C$ = -21.2‰) and indicative of a diet based on terrestrial animals and plants. There is evidence, however, that polar bears can have predominantly terrestrial diets. Remains of *Ursus maritimus* were discovered recently at Drangar, north-west Iceland (66° 21' N, 21° 52' W); a thoracic vertebra was radiocarbon dated to between AD 1690–1955 and gave a $\delta^{13}C$ ratio of -27.4‰ (T. Amorosi, pers. comm.). This ratio is even more

extreme than that of the Reindeer Cave cranium and suggests a diet comprising largely, if not entirely, non-marine food sources. Therefore, the C-isotope evidence is not inconsistent with the proposed re-identification of the Reindeer Cave cranium as *Ursus maritimus*.

The $\delta^{13}C$ ratio for the Reindeer Cave cranium further implies the presence of a terrestrial food source within the annual range of the bear and, by extension, the existence of an ice-free area with sufficient animal and plant biomass to support a large terrestrial omnivore. At glacial maximum the nearest ice-free areas to the Creag nan Uamh Caves are thought to have been in north-west Lewis (Sutherland and Walker, 1984) and north and east Caithness (Sutherland, 1984) both *c.* 100 km away, although nothing is known of the animal and plant life of those areas. Today, polar bears are found throughout the Arctic, generally on the circumpolar pack ice and on coasts bordering the Arctic Ocean, but they are known to penetrate considerable distances inland and often go without food for several months (Sage, 1986; Stirling and Guravich, 1990; Stirling, 1993). Movements of over 1,000 km have been reported (Kolenosky, 1987). Therefore, the presence of a polar bear 100 km from the nearest potential source of food would not be unusual.

There is also the taphonomic problem of how the cranium came to be within the cave. It is unlikely to have been deposited in the cave at glacial maximum, since at that time the entrances to the cave system (which today lie at an altitude of *c.* 330 m OD) were almost certainly deeply buried beneath ice. It could be argued that the animal died whilst crossing the ice sheet, its carcass became buried within the ice, and during or immediately following deglaciation the cranium was transported into the cave by some physical or animal agency, although this may be considered special pleading.

There is always the possibility that the date is incorrect owing to contamination by carbon of more recent origin. This could have occurred, for example, through the addition of chemicals during the specimen's museum life (no evidence of which was noted) or as a result of 'accelerator error' – the presence of residual ^{14}C in the accelerator (*cf.* Aitken, 1990). Because the concentration of ^{14}C is lower in old samples, small amounts of younger contamination can produce a large shift in apparent age. Thus, a relatively small amount of modern contamination could result in an apparent age of *c.* 19,000 BP for a sample that is several thousands of years older. Consequently, AA-18504 may represent a minimum age for the Reindeer Cave specimen. It is possible that the bear died at some time prior to the maximum of the glaciation when there were ice-free areas closer to the Creag nan Uamh Caves (or, indeed, the locality was still ice-free) and the entrance to Reindeer Cave was still open. Radiocarbon dating of reindeer antlers and bones from Reindeer Cave has indicated that the area may have remained ice-free as late as *c.* 22,000 BP (Murray *et al.*, 1993).

	Species	Site	Material	Lab. ID	Radiocarbon age BP	Cal BP age range (1σ)	Cal BP age range (2σ)	$\delta^{13}C$
BEAR:	*Ursus arctos*	Shaws, Dumfriesshire	Bone	AA-18503	7,590 ± 95	8,414-8,214	8,542-8,136	-21.2
	Ursus cf. *maritimus*	Reindeer Cave, Assynt	Bone	AA-18504	18,855 ± 215			-21.0
LYNX:	*Lynx lynx*	Reindeer Cave, Assynt	Bone	AA-18505	1,770 ± 80	1,804-1,560	1,871-1,517	-21.6
HORSE:	*Equus ferus*	Green Craig, Pentland Hills	Bone	AA-18506	10,165 ± 125	12,162-11,145	12,356-11,005	-21.1
MOOSE:	*Alces alces*	Whitrig Bog, Berwickshire	Bone	AA-18509	7,790 ± 100	8,601-8,415	8,951-8,364	-21.3
	Alces alces	River Cree, Wigtownshire	Antler	AA-18508	3,925 ± 80	4,501-4,236	4,560-4,093	-22.2
REINDEER:	*Rangifer tarandus*	Green Craig, Pentland Hills	Antler	AA-18510	9,710 ± 80	10,990-10,703	11,004-10,488	-22.2
	Rangifer tarandus	Rousay, Orkney	Antler	AA-18507	265 ± 75			-20.4
BEAVER:	*Castor fiber*	Middlestots Bog, Berwickshire	Bone	AA-18500	7,690 ± 95	8,542-8,366	8,593-8,216	-22.2
	Castor fiber	West Morriston Bog, Berwickshire	Wood (gnawed)	AA-18498	6,340 ± 90	7,361-7,172	7,389-7,017	-29.7
	Castor fiber	Linton Loch, Roxburghshire	Bone	AA-18502	6,170 ± 95	7,178-6,898	7,230-6,796	-22.5
	Castor fiber	Cleaves Cove, Ayrshire	Bone	AA-18499	2,785 ± 90	2,966-2,774	3,143-2,748	-24.3
	Castor fiber	Loch of Marlee, Perthshire	Bone	AA-18501	2,555 ± 80	2,754-2,486	2,785-2,356	-22.6

Table 1. AMS radiocarbon dates for some extinct Scottish mammals. The dates have been calibrated using the Calib 3.03 program (Stuiver and Reimer, 1993) – 20-years averaged atmospheric curve; lab. error multiplier set to K=1.

Lynx, *Lynx lynx*

The lynx has been recorded from only one locality in Scotland, the Creag nan Uamh Caves (Callander *et al.*, 1927; Peach and Horne, 1917), and only one specimen was available for dating, a partial skeleton (NMSZ 1990.26) from the Inner Chamber of Reindeer Cave. This gave a date of *c.* 1,800 BP (Table 1). Other lynx finds in Britain have been dated to the Devensian late-glacial and early Holocene, but none has been demonstrated to be later than Godwin's (1975) pollen zone VIIA (Jenkinson, 1983; Clutton-Brock, 1991). Jenkinson (1983) suggested that the lynx became extinct before or during pollen zone VIIA as a result of Mesolithic woodland clearance. Clutton-Brock (1991) also favours a date for the disappearance of lynx from the native British fauna around the middle of the Holocene. However, lynx are found in a variety of forested habitats in Europe and are recolonizing or have been reintroduced to several areas of western Europe (Breitenmoser and Breitenmoser-Würsten, 1990). The recent date for the Creag nan Uamh lynx indicates the much more recent survival of this species in Scotland and suggests that humans may have been implicated in its extinction through hunting and/or deforestation.

Wild horse, *Equus ferus*

Wild horse, wolf and reindeer remains were discovered in a rock fissure at Green Craig in the Pentland Hills, just south of Edinburgh (Henderson, 1887; Simpson, 1887). A sample from a cannon bone (NMSZ 1993.192.1) gave a date of *c.* 10,200 BP (Table 1), which is consistent with other dates recorded for the wild horse in Britain and its extinction during the early Holocene as climate and habitat changed (Clutton-Brock, 1991). The most recent radiocarbon dates for wild horse from Britain are 9,790 ± 180 BP (BM-2350) from Seamer Carr in north Yorkshire (Clutton-Brock and Burleigh, 1991) and 9,770 ± 80 BP (BM-1619) from the Darent Gravels in Kent (Clutton-Brock, 1991).

Reindeer, *Rangifer tarandus*

Two samples from reindeer were submitted for radiocarbon assay. A tibia from Green Craig was dated as 9,710 ± 80 BP (NMSZ 1993.192.11). This is similar to dates on reindeer remains from sites in Somerset, Kent and Yorkshire (Clutton-Brock and MacGregor, 1988). Together these dates are evidence that the species was still widespread in Britain at the beginning of the Holocene.

The second specimen dated as part of the present study is a large, almost complete, cast antler from a male reindeer that was found in a peat bog on the island of Rousay, Orkney in the Nineteenth Century (Smith, 1870). This was part of the collection of the National Museum of Antiquities, Edinburgh, but was recently transferred to the Department of Geology and Zoology, NMS (NMSZ 1993.160.6). There has been controversy as to whether this antler represents indigenous reindeer from the Pleistocene or early Holocene, or an antler cast from one of three animals that were imported in 1816 to Orkney by

William Traill (Smith, 1870; Harting, 1880). However, the imported deer did not survive their first winter, they were young animals, and are unlikely to have produced such large antlers.

The shape of the base of the antler indicates that the animal from which it came was probably a castrate (N. Murray, pers. comm.). Radiocarbon dating gave an age of 265 ± 75 BP (Table 1), making it probable that the antler was imported in the Seventeenth or Eighteenth centuries, possibly as a raw material for working. If this interpretation is correct, then it leaves the date of 8,300 ± 90 BP for a specimen from the Creag nan Uamh Caves, Assynt (Lawson, 1984; Clutton-Brock and MacGregor, 1988; Murray *et al.*, 1993) as the most recent radiocarbon date for indigenous British reindeer.

Moose, *Alces alces*

Like the lynx, it has always been considered that the moose became extinct during the early Holocene (Clutton-Brock, 1991). Two specimens were available for radiocarbon dating: a cast antler brought up in fishing nets from the estuary of the River Cree in Wigtownshire (Smith, 1870); and a cranium with the bases of both antlers recovered in 1870 from Whitrig Bog, Berwickshire (Smith, 1870). Both specimens were in the National Museum of Antiquities' collection and were recently transferred to the Department of Geology and Zoology, NMS (NMSZ 1993.160.17 (Cree), NMSZ 1993.160.8 (Whitrig)).

The Whitrig Bog specimen gave a radiocarbon date of *c.* 7,800 BP (Table 1) but the River Cree antler gave a much later date of *c.* 3,900 BP. Both dates are significantly younger than the latest dates for moose from England – the latest direct age measurements are 12,400 ± 300 BP (OxA-150) for a specimen from Poulton-le-Fylde, Lancashire (Hallam *et al.*, 1973; Gillespie *et al.*, 1985) and 9,490 ± 110 BP for a burnt fragment of moose antler from Thatcham, Berkshire (Wymer, 1962; Gowlett *et al.*, 1987), while moose is known to have been hunted in the early Mesolithic at Star Carr, north Yorkshire between *c.* 9,600 and 9,400 BP (Clark, 1954; Day and Mellars, 1994). The date for the River Cree find indicates the much later survival of moose in Scotland, which was suggested to have been later than the Ninth Century AD by Ritchie (1920) based on its Gaelic names of 'lòn' and 'miol'.

Beaver, *Castor fiber*

Five dates were obtained for Scottish beavers. The subfossil and archaeological remains of beaver in Scotland are described in Kitchener and Conroy (1996; in press). Three specimens gave dates of more than 6,000 years old – a skull from Middlestots Bog, Berwickshire (*c.* 7,700 BP; NMSZ 1818.30), a skull from Linton Loch, Roxburghshire (*c.* 6,200 BP; NMSZ 1933.99.2) and a piece of birch log (*Betula* sp.) with beaver tooth marks at each end from West Morriston Bog, Berwickshire (*c.* 6,300 BP). These dates confirm the presence of the beaver in the Borders prior to the Neolithic, and two further dates confirm its

survival into the late Bronze Age or early Iron Age – a piece of a mandible found in a cave at Cleaves Cove, Ayrshire (*c.* 2,800 BP; NMSZ 1995.41) and a skull from the Loch of Marlee, Perthshire (*c.* 2,500 BP; NMSZ 1993.160.5). A more recent date during the Dark Ages (*c.* 1,600 BP) has been suggested for a beaver incisor found in a midden at Edinburgh Castle (McCormick, in press). The beaver probably became extinct in Scotland during the Sixteenth Century owing to hunting for its fur, meat and castoreum coupled with habitat loss (Kitchener and Conroy, 1996; in press).

Conclusions

This paper presents radiocarbon dates for several species of extinct Scottish mammals, which were known to be extant at the end of the Devensian and into the Holocene. The dates on single bones of beaver, moose, wild horse and lynx reported in this article are the first direct dates for these extinct species from Scotland; while those for bear and reindeer add to the small number of dates previously available. Together, they represent a significant contribution to knowledge of the temporal ranges of the species.

The dates for moose and lynx indicate that those species survived much later than the Neolithic in Scotland and suggest that extinction for these species is likely to have been caused by habitat loss or hunting by humans rather than climatic and natural habitat change.

The date of *c.* 18,900 BP for the probable polar bear from Reindeer Cave, Assynt is not at variance with current ideas on the chronology of Late Devensian ice-sheet development in north-west Scotland, but may have been affected by contamination.

The dates on horse and reindeer from Green Craig near Edinburgh reinforce the view based on previous dates from elsewhere in Britain that both species were still widespread around the beginning of the Holocene. The date for a reindeer antler from Rousay is substantially more recent than existing dates on remains of indigenous reindeer from Scotland, and supports the conclusion drawn from other evidence that either the antler or the deer was a recent import from elsewhere in northern Europe.

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DISCOVERY OF MAMMOTH REMAINS FROM A RIVER BED IN EASTERN SUFFOLK

J. Latham

Introduction

A partial mammoth (*Mammuthus primigenius*) mandible with molar tooth and a number of smaller bone fragments were recovered from a river bed in eastern Suffolk. Pleistocene mammal remains have not previously been recorded in this part of the county. It is possible that the site may yield further mammoth fossils as well as being of interest for its stratigraphy and lithic artefacts.

Description

The mammoth remains were found in the bed of the River Glem near Hawkedon, some 10 km south of Bury St Edmunds, Suffolk. Here, chalk hills overlain by the chalky till are dissected by a series of shallow valleys which contain fluvial gravels and sands (Curtis *et al.*, 1976). At TL 801521 the Glem has cut a deep and steep-sided gorge into these deposits. The gorge walls on the southern bank are frequently slumped and heavily vegetated, although vertical cliffs up to 6 m high are exposed in places. The northern banks are shallower, rising some 3 m, behind which a semi-natural lake is held. The deposits comprise sands, gravels and cobbles predominantly composed of flint fragments, but with horizons of chalk-rich fluvial material. Downstream, the exposures become shallower with silty horizons containing mollusc shells. At the point where the remains were found, the stream bed is *c.* 3 m wide and has a chalk-rich deposit exposed at its centre: it appears that this is in fact chalk bedrock which has become saturated, soft, and mixed with in-washed material. The mammoth fragments found during October 1995 were largely loose on this chalk surface and had become partially embedded in it. It has not yet been possible to identify the source of the bones in the gorge walls.

The main mammoth bone fragment is part of the lower right mandible with associated molar tooth (Figure 1). The bone and tooth were lying assembled, but had cracked throughout and were collected in a number of fragments. The mandible was lying with its outer surface downwards in the chalky ooze and is well preserved; the upper streamward surface has been smoothed by water action. Several other bony fragments were recovered loose from the stream bed from within 1 m of the mandible and some of these could be fitted to it; other fragments appear to be from parts of the upper jaw and skull. Following collection, the bones were cleaned and slowly dried, and impregnated with PVA. The elements of the jaw were reassembled. Some unconnected pieces and a portion of the molar root were not impregnated, leaving an option for

Figure 1. The main mammoth bone fragment, part of the lower right mandible, with its associated molar tooth.

radiometric dating. Some surfaces of the mandible are well preserved and show delicate impressions of blood vessels. These surfaces are also affected by a number of lineations, up to 10 cm long, reminiscent of glacial striae.

Worked flints (identified by J.J. Wymer) were recovered from adjacent stream gravels. These include two blades and a number of probable waste flakes. No age can be given to these artefacts from the style of working, and it seems likely that they are not truly associated with the mammoth remains.

Interpretation

The molar tooth is third out of the five teeth a mammoth would use throughout its life, suggesting a young adult animal, perhaps between 20 and 30 years of age (A. Lister, pers. comm.). Mammoth remains within Pleistocene fluvial material are fairly common in Britain (Lister and Bahn, 1995), but none has previously been recorded at this locality; a portion of a mammoth tooth was recovered at Long Melford around 10 km to the south-east in the last century (J.J. Wymer, pers. comm.). The fossil is probably Devensian, although an earlier date cannot be ruled out.

The good state of preservation of the protected bone surfaces and the fact that the mandible, tooth and delicate roots were still connected suggests that the bones had not been transported very far. Additionally, the other bone fragments in the near vicinity suggest that more may remain buried; no excavation was

involved in this find. The site may therefore contain more mammoth remains and other fossils and is potentially valuable. The presence of lithic artefacts and molluscan remains in the vicinity add to its interest.

Acknowledgements

I am grateful to Adrian Lister for confirming the identity of the mammoth remains, and to John Wymer for his information on Suffolk mammoth records and lithic artefacts. Tim and Jane Orbell kindly allowed access to the land.

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THE GROUND FLORA OF THE BRITISH WILDWOOD

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It is a favourite popular delusion that the scientific inquirer is under a sort of moral obligation to abstain from going beyond that generalisation of observed facts which are absurdly called "Baconian induction". But anyone who is practically acquainted with scientific work is aware that those who refuse to go beyond fact, rarely get as far as fact.

T.H. Huxley (1896)

Introduction

It is well known that prior to the Neolithic expansion of agriculture, much of Britain was dominated by mixed deciduous woodland. The results of pollen analytical studies have allowed the tree species involved to be identified and the large-scale regional variations in this wildwood to be mapped. For example, Bennett (1989) has compiled a provisional map of forest types for the British Isles for 5,000 years BP, the age which 'probably represents the time of most complete development of British and Irish woodlands before the clearance of forest' (Bennett, 1989). At a smaller scale, Turner and Hodgson (1983) have used a network of pollen sites to study regional variation in woodlands of similar age in the northern Pennines. While pollen analysis can identify trees found in tracts of ancient forest, sometimes to species level, it cannot give detailed information on the composition of the ground and field layers and therefore the structure of the wildwood. Such information can only come from macrofossil remains or by analogy with surviving natural forests in other parts of the world (Rackham, 1990).

The aim of this paper is to argue that more attention needs to be given to the nature of the wildwood ground flora. We suggest that the image of the wildwood presented by many workers is incorrect for large areas of Britain 5,000 years ago. The ideas in this paper are somewhat speculative and intended to provoke discussion. They arise out of an ongoing study of macrofossil remains from mid-Holocene British woodlands. The macrofossil data included in this paper are illustrative of the results we have been obtaining and which will be published in full detail elsewhere. Their use here is to show that there is some evidence for speculations on the nature of the ground flora and to illustrate how these ideas can be tested.

The New Forest model of the wildwood

The conventional model (which we will call the New Forest model) of the wildwood was well described by Jones (1986). He wrote "By the sixth

Millennium BC, the woodland would in many places have closed up to form a cathedral of long straight trunks disappearing into dense high canopy ... The ground surface would have assumed a quite different aspect now that the major quest for light was taking place at a greater height. The plants found would be those that could grow quickly and flower before the deciduous leaves blotted out the sun." Smith (1992) also writes of "massive trees ... some of which when standing, rose to near 30 m before the first branch, while pines of similar stature are also recorded. These tell us, more eloquently than any number of pollen diagrams, what the mixed deciduous woods of lowland Britain actually looked like to the hunters and gatherers who so successfully exploited them." Rackham (1988) was also impressed by the size of some bog oaks from The Fens, and suggested that "Wildwood is unlikely to have had much of a scrub layer, because few of our native shrubs and tree saplings happen to grow well in shade. It would therefore have had only a modest capacity to feed deer and cattle, wild or tame."

These descriptions of the wildwood produce a picture visually similar to parts of the modern New Forest of Hampshire, that is large trees and a herb layer which is both species poor and of low density with much bare ground, due to a combination of grazing and low light levels on the woodland floor (Tubbs, 1986). It should be noted that while the two may have looked similar, the modern New Forest is **not** a natural unmodified woodland. This image of the wildwood appears to have been greatly influenced by the occurrence of very large 'bog oaks' from The Fens and other parts of Britain. The occurrence of such massive trunks has been known for a long time (Geikie, 1881) and may have had a disproportionate effect on reconstructions of the wildwood. Rackham (1988) has observed that, while some of these trees were over 35 m high, the abundance of Hazel (*Corylus*) pollen shows that much of the wildwood can have been at most half this height, as hazel produces little pollen when growing in deep shade.

The diversity of the wildwood ground flora

The herb and shrub flora of the wildwood is poorly recorded because these elements tend to produce very little pollen (Rackham, 1990). Macrofossil remains (seeds, leaves etc.) provide a much better record of these plants. We are currently engaged in a study of mid-Holocene British forests using macrofossil remains preserved in peats (mainly from submerged forests). This aims to provide more detailed information on the species composition, tree population structure and spatial heterogeneity in these woodlands than can be provided by pollen analysis. As Rackham (1992) pointed out, this methodology is a long overdue approach to wildwood ecology. This study is also producing data on the wildwood ground flora (e.g. Tables 1 and 2), which have prompted the speculations in this paper.

Table 1.

Summary of principal macrofossils (primarily seeds) from a bramble-rich monolith from the submerged forest at Wolla car park, Lincolnshire (Grid Ref. TF 557749). Radiocarbon date for wood from the monolith 4,500 ± 55 BP (OxA-5966). Main tree stumps at the site: alder (*Alnus*), oak (*Quercus*) and ash (*Fraxinus*).

Species	Number of macrofossil fragments
Bramble (*Rubus fruticosus* agg.)	51
Blackthorn (*Prunus spinosa*)	26
Sedges (*Carex* spp.)	5
Alder (*Alnus glutinosa*) [wood fragments]	2
Earthworm cocoons (Lumbricidae)	1

Table 2.

Summary of principal macrofossils (primarily seeds) from a bramble-rich monolith from Hyton Farm, Annas, Cumbria (Grid Ref. SD 096875). Radiocarbon dates from wood samples 4,415 ± 55 BP (OxA-5086) and 4,365 ± 50 (OxA-5087).

Species	Number of macrofossil fragments
Bramble (*Rubus fruticosus* agg.)	40
Bittersweet (*Solanum dulcamara*)	2
Rushes (*Juncus* spp.)	9
Sedges (*Carex* spp.)	728
Grasses (Poaceae)	113
Gipsywort (*Lycopus europaeus*)	36
Nettles (*Urtica dioica*)	9
Angelica (*Angelica sylvestris*)	1

Such sites are not a random sample of the wildwood; the means of preservation (peat growth) means that they tend to be wetter woodland sites. However, evidence such as earthworm cocoons shows that several of our woodlands were growing on mineral soils not peats, prior to the growth of the peat which preserved them. Two of these sites have ground floras rich in bramble (Tables 1 and 2). This plant is a robust, spiny, stand-forming shrub of woodland and scrub habitats (Grime *et al.*, 1990). From the perspective of human use of these woodlands it is of great interest for two reasons; it produces edible berries and vegetation dominated by this spiny plant can be almost impenetrable. Bramble pollen is hard to identify and is seldom listed in pollen diagrams (Moore *et al.*, 1991). This illustrates the importance of the macrofossil approach to investigating woodland ground flora.

Another of our sites is the submerged forest at the mouth of the Alt near Hightown, Merseyside. This was another area of wet woodland with birch (*Betula*), willow (*Salix*) and oak (*Quercus*) (Clapham *et al.*, in press) dated by Tooley (1985) to 4,545 ± 90 BP. The ground flora macrofossils at this site are dominated by the rhizomes of royal fern (*Osmunda regalis*), a large deciduous fern (Page, 1988) which would have provided a very dense ground cover in the summer months.

Although these sites with the best macrofossil preservation tend to be the wetter woodlands, they are of archaeological interest since there is evidence that such environments were utilised by humans. Examples include the Mesolithic site at Eskmeals on the Cumbrian coast which appears to have been on the edge of alder Carr (Bonsall *et al.*, 1994; Tipping, 1994) and the Mesolithic and early Neolithic site at Linsmore Fields, Buxton, Derbyshire which was also associated with wet woodland along the River Wye (Wiltshire and Edwards, 1993). Obviously such wet woodlands were used by humans and formed an extensive habitat, as illustrated by the extent of alder woodlands in Bennett's (1989) reconstruction of mid-Holocene British woodland types.

What of the drier woodlands? Were these mainly of the New Forest type? The drier sites tend to lack good macrofossil remains, and the herbs and shrubs tend to produce little pollen. However, modern woodlands can be instructive. For example, the areas of Wistmans Wood, an oak woodland on Dartmoor, which have been protected from sheep grazing have a thick bramble ground flora (Proctor *et al.*, 1980). Clearly, drier woodlands need not have a ground flora of the New Forest type. The role of grazers could have played a crucial role in affecting the nature of the ground flora. Within the British Holocene obvious candidates include the wild boar (*Sus scrofa*), red deer (*Cervus elaphus*), elk (*Alces alces*), roe deer (*Capreolus capreolus*) and aurochs (*Bos primigenius*) (Yalden, 1982; Stuart, 1995). As well as keeping some areas open, these animals could have created tracks through areas of dense undergrowth of use to humans for moving around or as sites for ambush-style hunting.

The key idea of this paper is that natural British woodland would have had a wide variety of ground floras. Woodlands of the 'New Forest' model were only one type and it is probably a gross simplification to think of most of the British wildwood as of this kind with few herbs or shrubs and easy movement between the trunks of very large trees. The diversity of ground floras would have had implications for human use of such habitats.

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THE 'ERROL BEDS' AND 'CLYDE BEDS': A NOTE ON THEIR EQUIVALENTS IN THE SOLWAY FIRTH

James Wells

Introduction

The presence of the Late Devensian marine Errol Beds (*c.* 18,000-13,000 ^{14}C BP) and Clyde Beds (*c.* 13,000-10,000 ^{14}C BP) in both central eastern and western Scotland has been well documented (see Figure 1; Peacock, 1981). To the south along the Solway Firth coastline there has been only very limited evidence for either of these sedimentary units. In this region, records of Ostracoda and Mollusca from the last century remain the only positive evidence of raised (*c.* 6-15 m OD) marine deposits containing a cold water fauna (Brady *et al.*, 1874). Three locations on the Rhins of Galloway - one at Stranraer and two near Port Logan - recorded broadly similar arctic marine faunas with the Mollusca *Leda (Portlandia) arctica* (Gray), *L. pygmaea* (*Yoldia lenticula*?) and *L. (Nuculana) pernula* (Müller) being common and the cold water ostracod *Cytheridea (Sarsicytheridea) punctillata* (Brady) present at all locations. Foraminifera analysis was not apparently undertaken. In recent years it has been suggested that these sediments equate to the arctic Errol Beds (Peacock, 1975; Sutherland, 1984). If these sediments are the chronological equivalent of the Errol Beds, their absence farther east in the Solway Firth region possibly reflects the presence of ice over the Southern Uplands up to *c.* 13,000 ^{14}C BP, thus supporting Sissons (1967) "Perth Readvance" limits for this region.

In a more recent study of relative sea-level change in the Solway Firth, no direct evidence for Devensian late-glacial sea levels was identified (Jardine, 1975). A radiocarbon date of 12,290 ± 250 BP on buried peats in an exposed section at Redkirk Point at the head of the Solway Firth indicates that relative sea level at this time was below 0m OD (Bishop and Coope, 1977).

New data

During the recent (1993) construction of a gas pipeline between Scotland and Ireland, the small embayment of Brighouse Bay (NX 635454) was used as the landfall location where the pipeline enters the sea. Trenching in the foreshore at this site revealed extensive buried peats (Maynard, 1994) that had previously been identified by Bishop and Coope (1977) and had been dated by them to 9,640 ± 180 BP. The precise stratigraphical context of this date was not clarified by Bishop and Coope but is probably from the lowermost part of the peats - a conclusion based on the author's own stratigraphical and radiocarbon dating programme. The trenching also uncovered a non-fossiliferous blue/grey diamict

beneath peat. This relationship has since been confirmed during recent stratigraphical work in the foreshore. Although no supervision of the trenching was undertaken, the spoil of these excavations remained in the intertidal zone for some time and J. Campbell (Coventry University) with the author retrieved a sizable amount of red silty clay with small stones observed as being attached to the blue/grey deposit. This indicates that these sediments lie directly below the blue/grey diamict. The altitude of the red sediments could not be measured but is probably close to or below *c.* 0m OD. A re-investigation of these sediments and further sampling was not possible without the aid of more sophisticated coring equipment.

The red silty clay with small stones (30g wet weight) was prepared for Ostracoda and Foraminifera analyses. All tests/valves were picked and identified, the results of which are summarised below:

Foraminifera	
Ammonia beccarii v. *batavus* Hofker	6
Elphidium excavatum f. *clavata* Cushman	146
Elphidium williamsoni Haynes	4
Elphidium magellanicum Heron-Allen and Earland	3
cf. Globulotuba sp. nov. (3) Jones	2
Haynesina germanica (Ehrenberg)	9
Haynesina orbiculare (Brady)	3
Polymorphina type	2
Total	**175**
Ostracoda	
Sarsicytheridea punctillata (Brady)	101
	(of which 7 were carapaces)
Total	**101**

The shells were generally in a good state of preservation indicating that reworking was at a minimum. Mollusca were rare in the sediments with only occasional juveniles and some fragments which were not identified.

Discussion

The microfauna of the red silty clay with stones from Brighouse Bay indicates a boreo-arctic marine provenance. The dominance of the ostracod *Sarsicytheridea punctillata* in these sediments is in common with those identified by Brady *et al.* (1874) in the Rhins of Galloway. The cold water temperature is further indicated by the similar dominance of the foraminifera *E. excavatum* f. *clavata*. However, the presence of thermophilous foraminifera

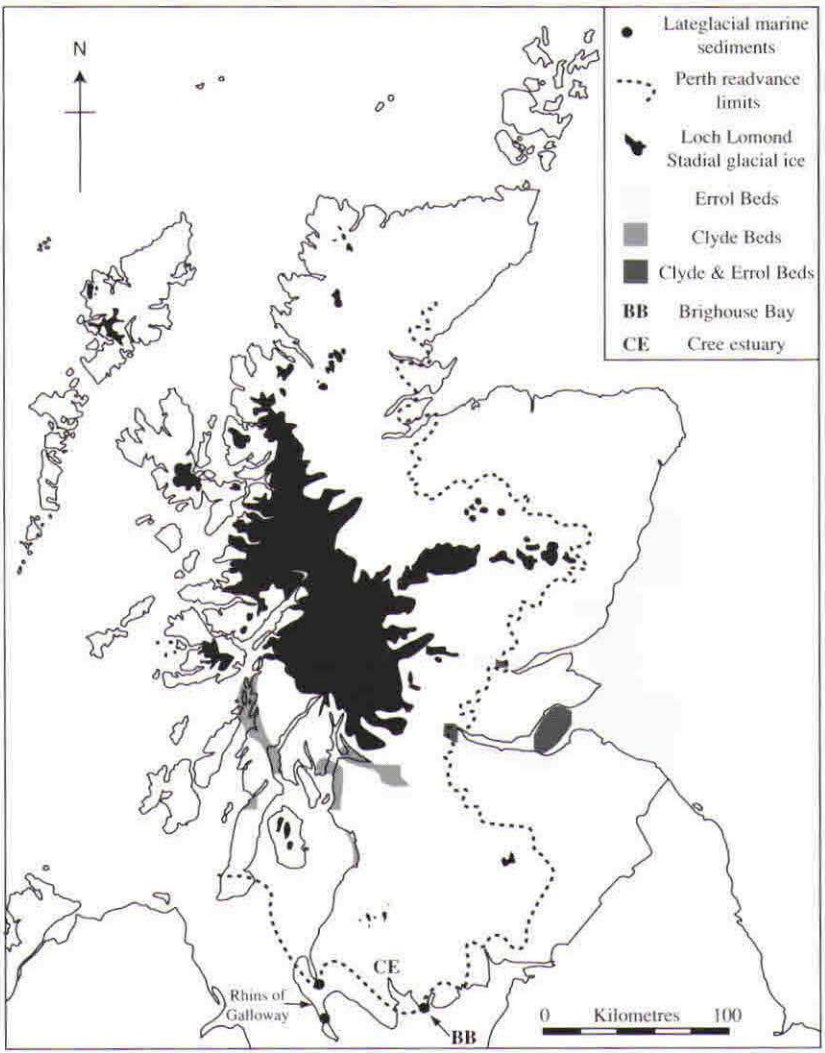

Figure 1. Perth Readvance limits based on Sissons (1967); distribution of Errol Beds and Clyde Beds from Peacock (1975, 1981); extent of Loch Lomond Stadial glaciers and ice caps from Sissons (1980); and the location of late-glacial marine sediments from Brady *et al.* (1874) and this paper.

species such as *A. beccarrii* v. *batavus* and *E. williamsoni* and the absence of arctic 'Errol Bed' ostracod species [e.g. *Rabilimis mirabilis* (Brady), *Cytheropteron montrosiense* Brady, Crosskey and Robertson and *Krithe glacialis* Brady, Crosskey and Robertson] may imply that the sediments from Brighouse Bay were deposited during the Windermere Interstadial (*c.* 13,000 to 11,000 BP) when marine water temperatures were higher than in the preceding Dimlington Stadial and the following Loch Lomond Stadial (Peacock and Harkness, 1990; Peacock *et al.*, 1992; Peacock, 1996).

Elsewhere on the borders of the Irish Sea at Aberdaron (North Wales) a similar foraminiferal fauna, dominated by *E. excavatum* f. *clavata*, from apparently glacigenic deposits was recorded (Austin and McCarroll, 1992). In this paper the authors have considered reworked marine sediments in glacigenic deposits to be indistinguishable from an *in situ* marine sediment on the basis of foraminifera test preservation and population size distributions. Central to their argument is that glacier ice travelled across and transported the marine sediments of the Irish Sea Basin only to redeposit them during deglaciation. The marine fossil-bearing deposits on the Rhins of Galloway could be explained by this model of events. However, at Brighouse Bay known glacier movement during the Late Devensian is generally considered to have been from north to south (i.e. from land to sea) (Sutherland, 1984). If Austin and McCarroll's suggestion is incorrect for one location it should not perhaps be assumed for others that surround the Irish Sea Basin. Certainly the possible allochthonous component of the microfauna of the Brighouse Bay sediments appears to be less obvious than in the Aberdaron samples. The monospecific ostracod assemblage from the Brighouse Bay sediments clearly shows no indication of reworked species.

Summary

The data presented here provide the first unequivocal evidence of a fossil marine deposit with a boreo-arctic microfauna in the Solway Firth. It has been hypothesised that these sediments are the equivalent of the pre-Loch Lomond Stadial Clyde Beds and do not correlate with those sediments of arctic marine provenance recorded in the last century in the Rhins of Galloway - as has been suggested elsewhere (Peacock, 1975; Sutherland, 1984) these sediments are possibly the Errol Beds equivalents. Alternatively, the Rhins of Galloway sediments may represent a derived glacigenic deposit. The author acknowledges that the circumstances under which the late-glacial sediments were recovered from Brighouse Bay were far from ideal, but this should not detract from the significance of the findings. It is clear that more detailed investigations in the Solway Firth region, both onshore and offshore, are required to identify the extent and chronology of these deposits. In doing so the information may contribute to current knowledge of relative sea levels, the pattern of isostatic

uplift and the distribution of Southern Upland ice during the late-glacial in south-west Scotland.

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REPORTS

REPORT ON THE 1997 INQUA SUBCOMMISSION ON SHORELINES OF NORTHERN AND WESTERN EUROPE FIELD MEETING TO THE AQUITAINE REGION, FRANCE

20th-25th April, 1997

The first field meeting of the INQUA Intercongress period from 1995 to 1999 was attended by 28 participants from 10 European countries. The meeting was organised by **Jean-Pierre Tastet** and **Laurent Masse** (University of Bordeaux), ably assisted by numerous excursion leaders from the Aquitaine region. The theme of the meeting was "Holocene coastal changes in the Aquitaine region, relationships with human settlements". The weather was glorious, the scientific sites stimulating, and the food and wine splendid.

Day 1

The meeting began with a visit to the magnificent Pyla sand dunes and a view over the ebb-tidal delta in the inlet of Arcachon Bay. At over 100 m, the Pyla dunes are the highest in Europe. **Jean-Pierre Tastet** showed four palaeosols in the system that have been radiocarbon dated to provide a chronology for dune development. Two palaeosols towards the base have dates of 3,500-3,200 BP and 3,200-3,000 BP respectively, and two higher in the system are dated to 300 BP and 19th Century. The development of the dune has been punctuated by deposition of thin freshwater diatom layers thought to be related to higher water tables.

The evolution of Sanguinet Lake was demonstrated in the field and at Sanguinet Museum by **Bernard Maurin, René Lalanne** and **Bernard Dubos**. The lake was created by the damming of a small local river by the coastal dune systems. Archaeological artefacts (wood canoes and stumps) from the lake bottom have been dated, and record a rise in lake level through time. Before 1,000 BC the lake was connected to the sea at a level of about 7-8 m NGF. The dune systems disconnected the lake from the sea around 100 AD. The lake level then began to rise, reaching 17-18 m at about 600 AD and its highest level of 23 m in the 18th Century. In 1840 the lake was artificially lowered to 21 m by construction of an overflow channel. At Sanguinet the participants discovered for the first time the meaning of the word "picnic" in France.

Day 2

Next, the group visited La Salie beach which displays a typical ridge and runnel form. **Denis Michel** explained the dynamics behind a southward migration of an offshore sand bank in response to changes in the Arcachon inlet to the north. A high frequency topographic survey has shown that the bank has migrated in the form of a sinusoidal wave, with an exponentially decreasing amplitude, and a simple mathematical relationship can be used to predict its future position. A short ferry ride across Arcachon Bay began a visit to Cap-Ferret where **Sandrine Aubie** described the historical evolution of the spit. Up to 1826, the spit had been lengthening through sediment supply by longshore drift and widening through aeolian supply. However, since the mid-19th Century, the end of the spit has oscillated around a pseudo-stable position. When the extremity of the spit extends, the seaward face of the spit is eroded, and *vice versa*. **Jean Favennec** presented a review of the management practices used to semi-stabilise the dune systems and slow down their landward migration. These practices are designed to protect urbanised areas behind the dunes from sand invasion. A tour through the Pleistocene fluvial terraces of the Gironde, upon which the vineyards of the Medoc are situated, followed by a visit to the cellars and a tasting of the Chateau Lascombes (Margaux) wines, provided a pleasant end to the day. **Pierre Becheler** described six terrace levels in Medoc each with a distinct lithology and related soil type. The age of each terrace has not been established.

Day 3

Laurent Masse and **Marie-Françoise Diot** started the day with a description of the Holocene sequences infilling Reysson Marsh. Rapid deposition of clay was followed by peat to the surface. The base of the peat has a radiocarbon date of about 6,000 BP, and since this time Reysson Marsh was mainly a freshwater peat bog. Located on a limestone high at the edge of the marsh at Brion is a Gallo-Roman settlement. **Mr Lacroix** provided a tour of the site describing remains of an amphitheatre and temple. The importance of the site is unknown, although it may have been an administrative centre. The surrounding marsh is likely to have been freshwater at the time the settlement was active. After a pleasant lunch stop in Brion, hosted by the mayor, the party moved to the broader marshes of the west bank of the Gironde Estuary to find the 'Cordon de Richard' chenier ridge. Under the guidance of **Laurent Masse**, the ridge was investigated at several sites, with the palaeontologists amongst the group feverishly excavating for the best samples. Radiocarbon dates on the shells in the ridge have varied between about 2,600 and 1,400 BP. The existence of the chenier is without doubt, whereas the events and processes that created such a high energy ridge, before and after sustained periods of low energy marsh sedimentation, still remain open to debate. The day ended at L'Amelie beach

south of Soulac-sur-Mer where historical erosion of the coast has been rapid. **Sandrine Aubie** demonstrated erosion at Pointe de la Negade that has averaged 7.3 m per year between 1957 and 1994. Second World War bunkers that were originally positioned on the dune top are now located in the intertidal zone.

Day 4

The morning visit was to a section of the Pleistocene substrate exposed at L'Amelie beach. A lagoonal clay ('argiles du Gurp') overlain by lignite, followed by sands and gravels containing cryoturbation structures and ice-wedge casts were described by **Jean-Pierre Tastet**. Gley and ranker soil horizons were developed in the sand and gravel units. The age of the lignite horizon is estimated to be older than 30,000 years and the ranker soil about 2,000 years old. The Soulac elephant (*Elephas antiquus*) was excavated from the lagoonal clay which was deposited during a period of high sea level. This species of elephant does not allow a definitive age for the clay to be established, but an ?Eemian age is postulated. South of Pointe de la Negade, at Le Gurp, is a depression in the Pleistocene substrate where an archaeological site is preserved. **Julia Roussot-Larroque** described the site in detail from its inception during the Epipalaeolithic through to the Iron Age. The remarkable feature of the site is its almost uninterrupted human occupation through this period. A pre-lunch visit to the archaeological museum in Soulac-sur-Mer presented the group with an opportunity (with a commentary by **Jacques Moreau**) to view the impressive Gallic military Boar standard and other artefacts collected in the local region. After lunch **Laurent Masse** and **Marie-Françoise Diot** described the Holocene sequence in La Perge Marsh. Pollen assemblages and extrapolation of radiocarbon dates have been used to correlate sequences across the marsh and to record palaeoenvironmental changes through time. A change from a brackish-water marsh to a continental marsh around 2,100 BP is correlated with the inception of the 'Cordon le Richard' chenier ridge.

Day 5

This was an early morning start when a tired and hungry (and possibly hungover) bunch of scientists crossed the Gironde Estuary on the ferry to be greeted by coffee and croissants at Royan. A Neolithic occupation site along the coast of Oleron Island was described by **Luc Laporte**. Stone pavements were described from a small excavation in the marsh where shell beads and copper artefacts were found. The marsh was freshwater at the time of the settlement, precluding a link to the sea. The artefacts are believed to have been used for trading with people in southern France and Spain. The afternoon was spent on Brouage Marsh where **Raymond Regrain** described the evolution of the marsh and the position of the coastline through the Holocene. The modification of salt

extraction methods through time was used as a basis for the evolutionary model. The Gallic shoreline was characterised by salt extraction using pans situated on the Cretaceous substrate around the marsh edge. The morphology of the salt basins on the marsh itself and the development of spit systems were used to locate the position of the shoreline from the 8th Century onwards. The day ended with a tour of the 16th to 17th century fortified harbour town of Brouage, provided by **Jimmy Vige**

Day 6

The final day of the meeting began with a visit to La Coubre spit at the mouth of the Gironde Estuary. The historical development of the spit between 1950 and 1996 and the formation of a small embayment (Bonne-Anse) behind was described by **Jean-Pierre Tastet.** A spectacular view of the dune coastline was provided from the top of La Coubre lighthouse. A picnic lunch was provided at the large Roman city of Moulin du Fa near Talmont. The layout of the city, its temple and surrounds were described by **Stephane Gustave.** Remarkably, it was estimated that if the entire site were to be excavated at the current rate of excavation, it would take 300-400 years! Moulin du Fa is therefore considered to be an important harboured city of Roman France. The final scientific stop of the meeting was on Saint-Ciers sur Gironde Marsh. **Simeon Mellalieu** introduced the party to the Holocene evolution of the marshes and compared the results with previous lithostratigraphic models for the Gironde Estuary. Finally, **Didier Coquillas** described the distribution of human settlements in the Medoc peninsula between the Neolithic and the Middle Ages, and their relationships with coastal changes.

This was an excellent field meeting with the party well satisfied with their week's discussions, if not a little heavier, after being treated to such fine French cuisine and Bordeaux appellation. The undying enthusiasm of field leader **Jean-Pierre "picnic" Tastet** is to be applauded. The Aquitaine region is certainly worthy of further investigation, so 'if you have a student and some money.....'

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THE QUATERNARY OF ISLAY AND JURA: QRA SHORT FIELD MEETING

5th-11th May, 1997

A group of about 17 members assembled at the Jura Hotel, attracted by the prospects of visiting some of the most impressive raised beaches in Britain, as well as sampling some of the equally distinctive local malts. This was the third of the recent series of meetings to the Scottish islands and was most ably organised and led by **Alastair Dawson** (Geography, Coventry).

Day 1

The morning involved the group being ferried by the local estate boat along Loch Tarbert to the bothy at Ruantallain on the west coast of Jura under a heavy swell and persistent squally showers. After lunch at the bothy, Alastair led the group in improving weather conditions to view the classic late-glacial raised shingle ridges resting on the till-covered High Rock Platform. He outlined the results of recent work involving the coring of small loch basins at the landward margins of the quartzite shingle ridge staircases which extend up to 35 m OD. Discussion and debate centred on the problems of dating the ridges, the origins of the shingle (derived directly from the underlying till or moved landwards from offshore?) and the origins of the ridges (individual storm or sea-level change events?). **David Bowen** (Geology, Cardiff) outlined the potential application of surface exposure dating methods. The group continued north to walk along the problematic Colonsay Ridge, a major shingle spit, with David Bowen speculating that it might be correlated with the Heinrich I event. Returning along the coast in the early evening sunshine, the problems of interpreting the age and the processes of origin of the Main Rock Platform were aired. A convivial evening then followed at Ruantallain bothy where the group spent the night.

Day 2

Next morning in the warm sunshine, the wonderful setting of Ruantallain was revealed as we waited for the return of the boat to ferry the main group across Loch Tarbert; against the backdrop of the classic view of the raised beaches photographed in the Geological Survey memoir for the area, the pioneering work of W.B. Wright was recalled. Leaving behind a detachment with **David Bowen** to collect samples from the raised beaches for surface exposure dating, we crossed to the lodge at Glenbatrick and appreciated the fine examples of Holocene beach ridges behind the lodge and the outwash grading into late-glacial beaches farther up the glen. After hearing about the problem of correlating the heights of raised beaches and which features should be measured,

the group continued along the glen, climbing up to the base of the Paps of Jura to examine what has been described as a fossil lobate rock glacier at the foot of Beinn Shiantaidh. Here, discussion focussed on the origins of rock glaciers (**Stephan Harrison**, Geography, Coventry) and the problems of interpreting process from morphological evidence alone. **Colin Ballantyne** (Geography, St Andrews), who had joined the group after traversing the summit of Beinn Shiantaidh, reported the presence of a series of slip planes and mass movements high on the mountain, raising the probability that the feature may at least, in part, be attributed to rock-slope failure. The apparent absence of similar features at the base of talus slopes elsewhere on the Paps of Jura lends some credence to this hypothesis. Consequently, rates of erosion and palaeoclimate conditions inferred from the rock glacier should be viewed with some caution. Having completed a coast-to-coast traverse of the island, the group then returned to the Jura Hotel and the comforts of hot water, the dining room and the bar. The more energetic members then partied into the early hours at a ceilidh in the bar organised for the birthday of one of the locals (who happened to work in the distillery!).

Day 3

The first visit was to a remarkable medial moraine extending some 3.5 km from the base of Beinn an Oir to the west coast of Jura. A few more energetic members of the group traversed Beinn a' Chaolais in hail, thunder and snow storms to examine evidence for trimlines and further slope failures. The main party walked along the south-west coast of Jura from Inver in search of the medial moraine. The 0.5 km walk Alastair promised the ceilidh-weary party turned out to be quite an expedition! Two splinter groups formed: one electing for a bit of gorge walking, whilst the less adventurous members of the party opted for the long-distance coastal route. The impressive nature of the feature we arrived at seemed to revive most members of the group. Several superb parallel lines of unvegetated angular quartzite boulders extend from the western slopes of Beinn an Oir. Seawards, the moraine is truncated by a late-glacial raised coastal terrace. Alastair described how this truncation demonstrated that high (*c.* 25-30 m) relative sea levels existed in this area during regional deglaciation. He suggested that the medial moraine, known locally as the Sgriob na Caillich (the old witch's slide) may have been deposited initially upon the surface of the Late Devensian ice sheet, with debris being supplied from frost riving on the Beinn an Oir nunatak. A discussion ensued as to the possibility that the Late Devensian ice sheet was thus relatively restricted in thickness. This debate continued the next day on Islay in respect of the anomalous high-level glaciomarine sediments on the Rhinns.

Later that day the main party quickly crossed over to Islay to visit the Loch Finlaggan Trust on the east of the island. **Mike Cressey** and **Geraint Coles**

(Archaeology, Edinburgh) described the history of the excavations which have taken place on Eilean Mor, a small island in the north-east of the loch and the former inaugural seat of the Lord of the Isles. Although now in ruins, the outline of a great hall, kitchen area and chapel were visible. Several superb gravestones engraved with characteristic Lord of the Isles warrior and ship were seen. **Lucy Norcliffe** (Geography, Coventry) and **Alastair Dawson** recovered a sediment core from the narrow stretch of water separating Eilean Mor (the big island) from the shore, for further analysis of the loch's sediment stratigraphy. The party then sped off to catch the last ferry back to Jura for our final night on the island.

Day 4

Day 4 began with a rush to catch the first ferry of the morning across to Islay. Following a stop to view the central Islay moraine and to discuss possible Devensian ice-sheet limits, attention focussed on the record of Holocene sea-level changes at Loch Gruinart. Alastair outlined the results of a recent programme of mapping and coring, which have revealed an early Holocene transgression, around 9 ka BP, pre-dating the Main Postglacial Transgression around 8-7 ka BP. Unusually for western Scotland, however, the period of marine transgression lasted until *c.* 2 ka BP and this may reflect the position of western Islay towards the periphery of the area of isostatic uplift. During the period *c.* 9-2 ka BP, the Rhinns existed as an island separate from the main part of Islay. The changing coastline and Holocene environments of Islay are also of interest from an archaeological viewpoint. In the course of several stops, **Steve Mithen** (Reading) outlined the significance of the area for Mesolithic human activity and settlement, describing the work of the Southern Hebrides Mesolithic project and the importance of integrating the archaeological evidence with the palaeoenvironmental record. Western Islay was an important source of flints during the Mesolithic, and initial transient settlement by bands of hunters was followed by a major phase of settlement *c.* 7.5 ka BP. The final series of visits was to the Rhinns, where Alastair presented the evidence for glaciomarine sedimentation up to *c.* 80 m OD. These sediments do not appear to have been overridden by glacier ice following their deposition. TL age estimates for the deposits place them during the Middle Devensian. One implication that follows is for a major phase of glaciation prior to between *c.* 75-45 ka BP at a time of high sea levels, which conforms with the hypothesis put forward earlier by Donald Sutherland to explain high-level marine deposits elsewhere in Scotland. Another implication is that the Rhinns remained an ice-free area during the Late Devensian. However, this seems more difficult to reconcile with offshore evidence further north to the west of the Hebrides, which suggests that the Late Devensian ice sheet there extended to the edge of the continental shelf; this would seemingly require major drawdown of ice in the vicinity of Islay.

Day 5

On the final day, time precluded a stop at South Ardachie Lead Mine near Loch Bharradail. However, while waiting for the ferry at the pier at Port Ellen, **Michael Cressey** and **Geraint Coles** summarised the results of their detailed studies into the environmental, archaeological and historical aspects of lead mining on Islay.

In sum, this was an excellent meeting, thoroughly enjoyed by all the participants, and one that continued the fine tradition established by the earlier Scottish islands' meetings.

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REPORT ON THE INTERNATIONAL CONFERENCE: "LATE QUATERNARY COASTAL TECTONICS" BURLINGTON HOUSE, LONDON

18th-19th June, 1997

This conference was organised by the INQUA Commission on Neotectonics and co-sponsored by the Geological Society of London's Tectonics Studies Group, the British Geomorphological Research Group, the Quaternary Research Association and the Commission on Tectonics of the International Union of Geological Sciences.

The aim of this meeting (organised by **Iain Stewart** (Brunel) and **Claudio Vita-Finzi** (UCL)) was the application of high resolution coastal chronologies to the testing and refinement of crustal models at local, regional and global scales. Twenty-three presentations were delivered over six sessions during the two days of the conference.

Day 1

The conference was opened with a keynote presentation by **Richard Peltier** (Canada) on earth rheology, glacial isostasy and relative sea-level history which provided a global framework within which studies of relative sea-level change cycles could be considered. **Yoko Ota** (Japan) and **John Chappell** (Australia) presented a paper which sought to decouple the issues of Holocene tectonism and eustasy, taking raised shoreline data from Huon Peninsula, Papua New Guinea as a case study. John Chappell was sadly unable to attend the conference following the sudden closure of his department. It was agreed that on behalf of the conference delegates, a letter would be sent to the Australian National University expressing dismay at its decision. **Robert Yates** *et al.* (USA) used investigations of offshore geomorphology to infer tectonic deformation along the Oregon and Washington continental shelves. He then considered the slip rate on a blind fault beneath the Oregon continental shelf. **Benoit Deffontaines** *et al.* (France) defined an integrated onshore-offshore approach for fault mapping which is permitting the reconstruction of Quaternary tectonics in south-west Taiwan.

Glenn Thackray (USA) examined rates of Pleistocene coastal deformation as recorded in the sediment sequence of the western Olympic Peninsula, Cascadia subduction zone, USA. In the first of two contributions, **Lisa McNeill** *et al.* (USA) demonstrated with the use of sidescan sonar data (and other methods), clear evidence of active deformation of submerged low-stand shorelines along the Cascadia subduction zone. **Anthony Orme** (USA) provided an analysis of Quaternary marine terraces and coastal deposits related to late Quaternary coastal tectonics along the California coast. **Paddy Nunn** (Fiji) examined

Quaternary tectonic changes associated with volcanism among islands along the northern Lau-Colville Ridge, south-west Pacific. **Jean-François Dumont** *et al.* (France) presented preliminary results of investigations of the development of the coastal morphology of western Ecuador in relation to the constraining geodynamic pattern. The final presentation of the first day, by **Rolando Armijo** *et al.* (France), discussed detailed evidence for the propagation of the North Anatolian Fault into the Aegean; specifically data on Quaternary uplift and flexure rates in the Corinth Rift. Following the first day's presentations and some informal discussion, the participants were treated to a sumptuous buffet reception in the rooms of the Royal Institution.

Day 2

Day Two began with a short summary presented by **Claudio Vita-Finzi** of work undertaken by **John Chappell** (Australia). **Colin Murray-Wallace** *et al.* (Australia) examined the relationships between coastal Quaternary tectonics and intra-plate volcanism along the Coorong to Mount Gambier coastal plain, south-east Australia. **Paolo Pirazzoli** *et al.* (France) provided results of a recent survey which sought to understand tectonic uplift rates along the south coasts of Iran based on sequences of Quaternary marine terraces and uplifted notches. **Pablo Silva** *et al.* (Spain) used data from the last interglacial marine terraces of the Gibraltar Strait area to infer patterns of coastal uplift along continental collision plate boundaries. **Claude Hillaire-Marcel** *et al.* (Canada) explained the dating applications of studies of Th-U systematics in fossil molluscs.

Ian Shennan *et al.* (UK) examined a 5,000-year record of sea-level change and large earthquakes in the Pacific North-West, USA as deduced from tidal marsh sequences. In the second presentation by **Lisa McNeill** *et al.* (USA) the conference learnt about the relationships between active continental shelf structures and the coastal lowlands of the Cascadia subduction zone. **Catherine Chague-Goff** *et al.* (New Zealand) presented evidence of Holocene and recent coastal tectonic deformation from the northern end of South Island, New Zealand, determined from sediments deposited by tsunamis generated by earthquakes. **Kelvin Berryman** *et al.* (New Zealand) proposed a high resolution model for the formation of a coseismic Holocene marine terrace sequence at Table Cape Mahia Peninsula, North Island, New Zealand.

In the first presentation of the final session, **Dale Dominey-Howes** (UK) used new sedimentological data from western Crete, Greece, to examine previously defined models of crustal tectonics for the eastern Mediterranean. Continuing the Mediterranean theme, **Ehud Galili** *et al.* (Israel) presented evidence of the tectonic stability or otherwise of the Israeli coast during historic times as determined by the relative position of ancient coastal installations to current sea level. The closing presentation of the conference was a keynote contribution by **Nick Flemming** (UK) who brought the conference back to the global theme

addressed in the opening paper by **Richard Peltier**. He presented considerable archaeological evidence to demonstrate vertical tectonic movements on the world's continental shelves during the Palaeolithic, Neolithic and Bronze Age.

During lunch on the second day of the conference, a business meeting of the INQUA Commission on Neotectonics, chaired by the Commission's President, **Professor Carlo Bartolini** (Italy), was held in the Arthur Holmes room. Various issues were discussed including recent project grants and the theme of the 1999 South Africa Conference. For further information please contact **Iain Stewart** (Brunel, UK).

After the close of the conference, copious intoxicating drinks were provided in the splendid surroundings of the Linnaen Society, Burlington House. In such a short space it is impossible to do justice to the quality of the work presented. However, the overriding feeling was that this was an excellent meeting which benefitted from the participation of numerous respected and noteworthy academics. Congratulations are to be offered to **Iain Stewart** and **Claudio Vita-Finzi** and their many helpers (including the projectionist!) for their hard work in organising such an important and successful conference. A special publication of the Geological Society based on the conference is forthcoming.

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REPORT OF THE SECOND ANNUAL IGCP-396 CONFERENCE DURHAM UNIVERSITY

Continental Shelves in the Quaternary (1996-2000)

21st-23rd July, 1997

Rationale of the IGCP-396

Continent-ocean correlation is based mainly on comparison of terrestrial and deep-sea records. Correlation with the shelf record is underexposed, perhaps due to lack of a major ODP work on continental shelves. The main objectives of IGCP-396 are to study and interpret the Quaternary sequences on continental shelves to permit global correlation of sea-level and climatic changes and at the same time identify beneficial uses for humankind.

Durham Conference

The sessions of the conference held in Durham University (hosted by **Bill Austin**, Physical Geography Department) dealt with regional perspectives, palaeo-oceanographical, -sedimentological and engineering aspects of the shelf. The conference was attended by about 50 delegates from laboratories in Australia, Japan, India, Hong Kong, China, Canada, Russia, Israel, and various European countries. Discussions were very lively and stimulating in the workshops and after each lecture. Summaries of the workshop discussions will be given on the web by the workshop leaders (see the home page of IGCP-396). As with any meeting of this kind, the themes addressed tended to be strongly biased towards the participants and the subject seems to lack a coherent plan for those working on the shelf seas; this is one reason why IGCP-396 is so important.

Day 1

On the first day, presentations centred on regional perspectives of Quaternary shelf studies. It appears that a number of recently started shelf studies are well underway. In contrast to the first meeting, most of the presented studies at this meeting limited themselves to the late Quaternary (last glacial cycle).

The subjects of the talks varied from siliciclastic to carbonate environments and from typical case to methodological studies. Data from the North Sea Basin for reconstructing palaeo-sea levels were presented by **Ian Shennan** (LOIS program, Durham) and compared with the ice-unloading numerical model of Lambeck (1995); aeolianites of the continental shelf of Israel were dated by various luminescence methods and by land snails and comprise a record

covering the last 70,000 years (**G. Gvirtzman**). **Heiner Josenhans** (Dartmouth) presented a new, quick and accurate swath method and showed examples from a number of surveyed sites along the east and west coast of Canada. The swath data can be converted to detailed images of sea-floor morphology. **Gilles Leriocolais** (Ifremer) showed very high-resolution seismics in combination with swath bathymetry data to understand Plio-Pleistocene sedimentary successions and their bounding (discontinuity) surfaces in the English Channel palaeo-valleys. The stratigraphy of the western continental shelf of India was discussed on the basis of shallow seismics, with an emphasis on the presence of submarine terraces of various origin (waves, reef growth, tides). A delegation from China presented data on various aspects of the continental shelf of South China. **Chen** (Guanghzhou) discussed environmental aspects, **Zhao** (Shanghai) discussed stratigraphy and palaeoenvironments recorded from shelf cores of the East and South China Sea, and **Zhu** (Nanjing) discussed the benthic foraminiferal records of the Arabian Sea continental shelf. Environmental changes during the Last Glacial Maximum in the Yellow Sea and East China Sea were discussed by **Yoshiki Saito** (Japan). An extensive study on sea-level changes in the Black and Caspian seas was presented by **Andrei Selivanov** (Moscow), who also discussed the timing of overflow from the Caspian to the Black Sea. The study further indicated that the major transgressions in the Black Sea coincided with those in the world's oceans. A detailed litho- and bio-facies study was made of the west Australian continental margin cool- to warm-water carbonate transition and showed the complexity of carbonate deposition in the 'subtropical' carbonate realm (**Lindsay Collins** and co-workers, Perth).

Day 2

The second day focussed on palaeo-oceanography. In a presentation on shelf modelling of tides and tidal changes, **Ann Hinton** (Leeds) expressed the importance of establishing areas where the accuracy of the results can be tested. A first requirement for reasonable accuracy is knowledge of palaeogeography, former offshore water depths and types of sediments, an important reason for present studies to focus on the last post-glacial transgression. **Kaplin** (Moscow) presented both published and unpublished reconstructions of the Late Pleistocene and Holocene of the Black Sea and northern Eurasia, Madagascar and Seychelles Bank. **Gillian Scott** (Wales) assessed the value of foraminifera species in downcore studies of shelf water stratification using assemblage characteristics and geochemical properties as environmental indicators. **Bill Austin** (Durham) provided evidence for the timing of deglaciation based on stratigraphies of shallow marine cores from the north-east Atlantic margins from about 15.2 ka BP. **Richard Holmes** (BGS, Edinburgh) showed shelf studies comprising the entire Quaternary succession based on an extensive database of seismic and borehole data. **Bridgland** (Durham) ended the session by giving an overview of the Quaternary evolution of the southern North Sea Basin. The rest of the

afternoon was spent by workshops in: 1) dating and sequence stratigraphy; and 2) modelling shelves by analogue and numerical experimental models. The outcomes of these discussions will be published on the web.

Day 3

Knowledge of sedimentological and engineering properties of shelves is vital for large constructional works that are increasingly carried out on the shelf. On the third day, a number of talks addressed this topic using case studies. **Aileen Davies** (Hong Kong) discussed the sedimentary succession at Kai tak airport. **Anita Choy** (Hong Kong) discussed the inner shelf of Hong Kong. **Mike Paul** (Herriot Watt, Edinburgh) presented studies of the geotechnical properties of the outer continental shelf and slope of west Scotland, and **Wiss Yim** (Hong Kong) discussed the importance of pedogenesis and desiccated crusts of the Hong Kong shelf. **Jose Silva** (Porto) applied statistical methods to geotechnical offshore shelf data of Macau, **Yang** used artificial neural networks for the assessment of geotechnical properties of mud and **Keith Tovey** (Norwich) presented a new algorithm to enable particle-size determination from bitmaps of SEM images. The afternoon was spent on three workshops elaborating on palaeo-oceanography and geotechnical properties of shelves, and on siliciclastic and carbonate sediment distribution on shelves. The next international meeting of IGCP-396 will be held in Goa, India.

(see also the home pages on the web: http//www2.env.uea.ac.uk/gmmc/igcpmain.html)

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REVIEWS

BRITISH REGIONAL GEOLOGY LONDON AND THE THAMES VALLEY (FOURTH EDITION)

Compiled by M.G. Sumbler
British Geological Survey
HMSO, London
ISBN 0-11-884522-5 1996. 173pp, Softback £14

Producing an acceptable chapter on the Quaternary, or any other time period, for a regional memoir is always a fine balancing act. The writer has to reduce extensive and complex material to a few pages, produce material understandable to the generalist dipping into the subject matter for the first time and please the specialist. These ends have been achieved successfully in this case. The summary is very clear and concise, but all the main points of current interest and discussion are covered. A broad spectrum of Quaternary specialisms has been visited and recent developments in Quaternary science are well represented.

The interest for the Quaternary community starts in Chapter 8, the Palaeogene and Neogene, with a description of the Red and Norwich Crags. A concise, useful outline of the distribution, sedimentology, mollusca, tectonic history and palaeogeography of the Crags is given and there is a brief discussion of their chronostratigraphic relationship to the Pleistocene. I was left with a feeling of frustration that more detail and discussion did not occur, for example, the work of Mathers and Zalasiewicz (1988) on the extension of the Crag sea across the London Basin seemed underplayed, particularly as there was a blank half-page at the end of the chapter. However, such discussion could be argued to be more appropriate for the East Anglia volume.

Chapter 9 describes the Quaternary. A brief introduction to the development of Quaternary stratigraphy, climatic change and dating methods, with a very useful summary in Table 9, sets the scene well. The full terrace sequence of the whole Thames system is summarised very successfully, from the re-evaluation of the Northern Drift of the Upper Thames to the Holocene succession of the Lower Thames, supported by four figures. The summary brings in all the main points of current discussion, such as the nature of the Northern Drift, significant changes in the gravel composition and the implications for reconstructing the palaeogeography of the Thames, and the relationship of the terraces to the oxygen isotope chronology. For the generalist, a better link with the last part of the previous chapter explaining the development of the Thames as the Crag sea retreated and a brief explanation of the basis of the terrace correlations between

the Upper Thames and eastern Essex would have been useful. The section follows the views of Bridgland (1994, 1995). Though this makes for a simpler narrative, without the views of Gibbard (1994, 1995), it presents a somewhat unbalanced picture of the debate about the chronology of the terraces.

The variety of phenomena associated with Anglian ice advance (Oxygen Isotope Stage 12), the formation of proglacial lakes, tunnel valleys and the diversion of the Thames are appropriately introduced. The multiple tills of the Vale of St Albans are mentioned, but not those of the Chelmsford area (Cheshire and Whiteman, in Allen *et al.*, 1991). The evidence for further glacial activity in Stage 10 is discussed. Since the volume was written, there has been further relevant work, for example, Hopson (1995), describing the chalk rafts of the Chiltern scarp in Hertfordshire.

The Holocene history of the Lower Thames is explained clearly, following Devoy's (1979) work, but the inevitable has happened and the concept of crustal downwarping in the outer estuary is being re-examined (e.g. Long, 1995) and a possible re-interpretation is provided by Haggart (1995). Sadly, the interesting work of Nunn (1983) on evolution of the Thames in central London and its influence on the present topography and geography is not referred to. This would have a particular appeal to the generalist reader.

'Man in the Quaternary' provides an excellent summary of the archaeology of the Thames, describing the artefacts of the various industries, their possible uses and their context. It might also have been germane to mention that a view exists that the Clactonian and Acheulian industries might not be culturally distinct (Ashton and McNabb, 1994).

Within the chapter, there were some disappointments. The origin of the Clay-with-flints is ascribed mainly to dissolution of the Chalk, ignoring the work of Hodgson *et al.* (1967) and Catt and Hodgson (1976). Involutions are considered to be due to frost heave, despite the widely held view that they are load structures, as reviewed by Ballantyne and Harris (1994). There was no discussion of palaeosols, despite their importance within the Middle Pleistocene sequence, for example, in the Chelmsford area (Kemp, 1985; Rose *et al.*, 1985). The description of the Anglian starts somewhat shakily by emphasising glacial erosion, the presence of Scandinavian erratics and the finest material being silt, when the area is typified by deposition, much of it clay grade, by an essentially British ice sheet.

Applied aspects of the Quaternary are covered in Chapter 10, 'Geology and Man'. The importance of the Quaternary in the supply of sand and gravel and of water is brought out, though the use of Quaternary material for brick-making, as at Marks Tey, is omitted. The Quaternary origin of geological hazards, such as 'local hollows' (p. 153), causing ingress of water during tunnelling, and landslips is not made obvious.

Throughout, the lack of literature references in the text makes it difficult to follow through some of the points raised. In particular, no allusion is made to Gibbard's work on the Thames, though some of it is included in the reference list

Inevitably anyone involved in the Quaternary of the London Basin will feel that relevant material has been left out; this review reflects such an attitude and possibly, unfairly, gives a pejorative impression of the book. In fact, Mike Sumbler, Peter Balson, David Bridgland and John Wymer have been a strong team who have provided a very readable, useful, concise updated review of the Quaternary of the London Basin. Current ideas are presented clearly, judiciously supported with 13 maps, figures, plates and tables.

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KARST AND CAVES OF GREAT BRITAIN

A.C. Waltham, M.J. Simms, A.R. Farrant and H.S. Goldie
Chapman and Hall, London
ISBN 0-412-78860-8, 1997. 358 pp, Hardback £115

This latest volume of the GCR series summarises the survey results of the karst regions of Britain. The survey (1978-1990) is divided into two parts: caves of Britain and surface landforms. The remit was to put on record the scientific reasons for conserving sites and to put them in their wider geomorphological context. It is not a fieldguide. At last, a book which deals with karst features throughout Britain! In the past we have had *Limestones and caves of the Peak District* and *Limestones and caves of Wales* to name but two by T.D. Ford.

The book is divided into 8 chapters starting with an introduction to the karst landforms, types and cave evolution. Two useful diagrams of Great Britain show the geographical and chronological extent of karst-forming rocks including evaporites. A section on 'Research in limestone geomorphology' includes discussion of cave sediment dating and the effects of Quaternary glaciation on karst landforms. The Introduction summarises the criteria for GCR site selection.

Chapters 2 to 8 deal with the major karst regions within Britain, starting with the Yorkshire Dales, arguably the best known British karst. Each chapter has an introduction to the karst and caves of the region followed by a breakdown of the individual sites. Eighteen are listed within the Yorkshire Dales chapter, some cave systems, some areas such as Malham Cove. Each site report starts with highlights followed by an introduction, detailed description, interpretation and conclusion. Each entry has maps and often accompanying photographs or cross-sections. All chapters follow this format.

Chapter 3 is entitled 'Outlying karst areas of the northern Pennines'. This is probably the most extensive karst landscape within Britain and deals with 17 sites on the Alston and Askrigg Blocks, the Vale of Eden and the southern part of Cumbria.

Chapter 4 deals with the limestones and caves of the Peak District in 13 sites, from the caves of Castleton and the Winnats in the north, to the caves of Matlock and Masson Hill in the south.

The Mendip Hills karst area is the subject of Chapter 5. Twelve sites, including the famous Cheddar Gorge and Wookey Hole, are described and illustrated.

Karst in Wales is Chapter 6. North and South Wales are dealt with separately, emphasised by maps of the South Wales Coalfield and the Clwydian Hills in North Wales. The Wye Valley, south Dyfed and Anglesey are mentioned within subsections in the Introduction. Twelve sites are listed, the extensive Minera Caves and the Alyn Gorge Caves in north-east Wales, the other 10 located in South Wales. These include the deepest cave system in Britain, Ogof

Ffynnon Ddu, and the only turlough in the Welsh karst, Pant-y-Llyn on the North Crop of the South Wales Coalfield.

While chapters 2-6 have dealt mainly with the Carboniferous Limestone, 'Outlying karst areas in England' looks at the chalk, karst developed on salt, gypsum and other minor limestones. Slaughter Stream Cave is located in the Worcester Syncline, Buckfastleigh Caves and Napps Cave are developed in Devonian limestone, Cull-pepper's dish is a doline within the Dorset chalk, the Devil's Punchbowl another doline north-east of Thetford in Norfolk, the Manger and Devil's Dyke are chalk combes in Berkshire and Brighton. Beachy Head Cave is located on the coast in the east Sussex chalk and Water End Swallow Holes lies in North London as does Castle Lime Works Quarry with its well developed Tertiary clay-filled pipes. The dry valley systems of Millington Pastures form the subject of the next site description while the subsidence hollows of Cheshire salt solution are the last two sites: Moston Long Flash and Rostherne Mere, in this very 'mixed bag' chapter.

Chapter 8 is simply titled 'karst in Scotland' and makes the point that karst development is minimal within the landscape features of Scotland. The Assynt Karst is the one exception. Two sites are described; Traligill Valley and Allt nan Uamh Caves in the Durness limestone.

An extensive reference list follows with a 6 page karst glossary and a list of grid references for each site. The index is useful as it distinguishes between figures and tables within the page numbers.

In some ways I think it is a pity that each chapter did not have its own reference list. However, this book goes a long way towards bringing all nationally important karst sites together in one place. It must be remembered that this is a GCR review and so not all sites are listed, only those deemed suitable for extra protection and conservation.

Overall I think this is a valuable contribution to both karst research and to geological conservation. The Nature Conservancy Council which initiated the series, and the Joint Nature Conservation Committee which undertakes publication are to be congratulated on another very useful addition to the review series.

Volume 12 adds greatly to the current state of knowledge of key earth science sites and when all 42 volumes are published, Britain will have a resource which will be the envy of most other countries.

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ABSTRACTS

A STUDY OF LOWER AND MIDDLE PALAEOLITHIC ARTEFACTS FOUND IN RELATION TO DEPOSITS MAPPED AS CLAY-WITH-FLINTS ON THE CHALK DOWNLANDS OF SOUTHERN ENGLAND

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The Chalk downlands of southern England, which are capped with deposits mapped as Clay-with-flints, lay beyond the Anglian glacial maxima and have remained untouched by direct glacial activity since at least the late Cromerian (around 500 ka BP). During the past 100 years or so many Lower and Middle Palaeolithic artefacts have been found on these downland hill-tops and plateaux, yet the British Lower and Middle Palaeolithic archaeological record is based almost exclusively on material recovered from low-level sites (e.g. riverine locations, beaches and caves). Arguably, the Lower and Middle Palaeolithic artefacts found in relation to deposits mapped as Clay-with-flints on the Chalk downlands of southern England represent the most neglected realm of British Palaeolithic research.

As part of this study, a detailed gazetteer was produced which lists the recorded palaeoliths, both surface and embedded finds, from the downlands, along with associated geological details. In addition, a separate comprehensive review of all the embedded hill-top and plateau sites/finds was conducted. A 'bench mark' system has also been developed for the field archaeologist searching for *in situ* Palaeolithic sites, to assess particular levels of change/erosion on any specific hill-top/plateau. To learn more about the deposits mapped as Clay-with-flints and the associated palaeoliths, a case-study excavation at Wood Hill, east Kent, was undertaken. Detailed geological, geomorphological and sedimentological methods of recording were employed. Analyses of the data from this and earlier excavations here, suggested that Wood Hill is an *in situ* Lower Palaeolithic site with at least two separate occurrences.

This study has confirmed the importance of the Lower and Middle Palaeolithic artefacts found in relation to deposits mapped as Clay-with-flints on the Chalk downlands of southern England and has demonstrated the value of a new methodological approach to these sites - an approach which is essential to maintain the integrity of both sites and artefacts.

THE ROLE OF VEGETATION DYNAMICS AND HUMAN ACTIVITY IN LANDSCAPE CHANGES THROUGH THE HOLOCENE IN THE LAIRG AREA, SUTHERLAND, SCOTLAND

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This research forms a key part of a wider multidisciplinary project centred on the archaeological excavations just south of Lairg village in Achany Glen. Sub-fossil pollen analysis was the primary method for investigating the vegetation history, with complementary studies of loss-on-ignition, charcoal content, degree of mineral inwashing and modern vegetation pollen.

Three sites were carefully selected to be representative of local-regional scale pollen recruitment: Achany Glen Site 1 (AG1) - a small lochan, where cores were extracted from the shore - AG1S, and from the lochan centre - AG1L; Achany Glen Site 2 (AG2) - a woodland hollow site and Achany Glen Site 3 (AG3) - a valley mire. When compared, the results of the pollen and charcoal analyses from each of these sites showed differences which could be attributed to the differences in the nature of pollen recruitment to each site. The combination of local-regional scale pollen recruitment sites enabled a more comprehensive reconstruction of the vegetation and landscape history of Achany Glen. Both AG1S and AG1L produced sediments which could be dated to the earliest part of the Holocene, with AG2 providing continuous sequences from the early Holocene, and AG3 providing a continuous sequence from *c.* 8,800 cal. BP. The probable hiatus from *c.* 6,000-3,500 cal. BP at AG1S provided possible proxy evidence of a drier climatic phase which enhanced the interpretation of the pollen data. The results of the modern vegetation and pollen studies could be applied to the interpretations of the sub-fossil pollen data using multivariate analyses. For the local sub-fossil pollen assemblages of AG2 and AG3, this highlighted trends in habitat changes through time.

Chronologies were established using radiocarbon dating for all sites, with additional independent chronologies provided by ^{210}Pb dates at AG2 and AG3 and three tephra horizons - Hekla 4, Glen Garry and Loch Portain at AG3. The ^{210}Pb dating in conjunction with the historical date for the Loch Portain tephra was particularly successful in dating the last *c.* 450 years at AG3. The comprehensive chronologies for each of the sites enabled firm correlations to be made with the radiocarbon chronologies obtained by the archaeological investigations.

The regional vegetation history of the area showed a landscape predominantly wooded from *c.* 8,000 cal. BP through to *c.* 5,000 cal. BP, with a steady

reduction in woodland cover and increasing dwarf shrubs to the present. The research was able to demonstrate that selection of sites reflecting local vegetation change enabled a more detailed and complex vegetation history to be reconstructed. AG2 reflected local changes in the valley of Achany Glen, showing the site was continuously wooded through the Holocene, excepting a period from *c.* 2,000-1,000 cal. BP when human impact in the whole area was most intense. The woodland was predominantly birch and oak, with pine occurring only from *c.* 7,200-6,000 cal. BP, despite continued dominance of this species on upper slopes of the Glen after this time. Human presence in the wood is suggested from *c.* 8,000 cal. BP, and there is evidence of probable cultivation from *c.* 6,100 cal. BP. AG3 could be linked to the local excavations on the valley side of Achany Glen; here woodland cover became and remained sparse from *c.* 4,500 cal. BP, with evidence of changing landuse from the Bronze Age to the present. The discovery of three tephras at AG3, enhanced the chronology of the site and enabled a hypothesis to be proposed of long-term cycles of vegetation and landuse change following volcanic eruptions.

Construction of a dynamic model brings together a summary of the conclusions presented by the multidisciplinary investigations of the Lairg project. In this model local-regional vegetation succession in Achany Glen can be linked to the changing nature of human impact in the area to illustrate the nature of landscape change through the Holocene.

THE PALAEOECOLOGICAL RECORD OF HOLOCENE ENVIRONMENTAL CHANGE IN SOUTH-WEST TURKEY

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This thesis examines natural and anthropogenic Holocene environmental change in south-west Turkey. Pollen and non-siliceous microfossils were recovered from four sediment cores from Gölhisar Gölü (37°8'N, 29°36'E; elevation 930 m amsl), a small intramontane lake in Burdur Province, south-west Turkey. The pollen and non-siliceous microfossil assemblages from the longest core (GHA: 813 cm) record changes in local and regional vegetation and lake productivity over the last ~9,500 years. Pollen spectra indicate that vegetation progressed from an open landscape with an increase in arboreal pollen occurring ~8,500 BP to mixed forest comprising oak, pine and juniper until around 3,000 BP (Cal ~1240 BC) when a human occupation phase becomes discernible from the pollen spectra. This occurs shortly after the deposition of a volcanic tephra layer which originated from the 'Minoan' eruption of Santorini (Thera) and which has been radiocarbon dated to 3,330 ± 70 BP (Cal ~ 1600 BC). This human occupation phase is comparable to the Beyşehir Occupation recorded at other sites in south-west Turkey and involved forest clearance and the cultivation of fruit trees such as *Olea*, *Juglans*, *Castanea* and *Vitis* together with arable cereal growing and pastoralism. The presence of pollen types associated with the Beyşehir Occupation phase in deposits above the Santorini tephra layer confirms a Late Bronze Age date for its commencement. The Beyşehir Occupation phase at Gölhisar Gölü came to an end around 1,300 BP (Cal ~700 AD) when pine became the dominant forest tree.

Sediments from a short core containing the ~3,300 BP Santorini tephra layer were subjected to high resolution pollen analysis (every 0.5 cm) to determine whether this major volcanic eruption had an impact on terrestrial and aquatic ecosystems. The results suggest that the eruption had no effect on terrestrial biota at Gölhisar, or the effects were short-lived and cannot be detected even with fine-interval sampling. However, deposition of the tephra had an effect on some aquatic non-siliceous microfossils, which exhibit an immediate response. Because of the interaction between tephra deposition and sediment lithology, it is not possible to conclude if changes in the abundance of coenobia of *Pediastrum* and *Coelastrum* were the result of tephra deposition or an indirect result of lithological changes following deposition of the Santorini tephra.

Volcanic glass shards recovered from Gölhisar Gölü were subjected to analysis of shard morphology, electron microprobe analysis for major-element determination, and solution and laser ablation Inductively-Coupled Plasma Mass Spectrometry to determine trace-elements. The results are consistent with previous investigations and indicate that the tephra layer at Gölhisar Gölü is unambiguously sourced to the 'Minoan' eruption of Santorini.

LETTERS TO THE EDITOR

1. SOIL UNITS IN THE STRATIGRAPHICAL CODE

Salvador (1994, p. 2) states:

> *Soil and soil-stratigraphic units have not been covered in the second edition of the Guide. The stratigraphic treatment of soils needs additional consideration before attempting to formalise principles and procedures and to incorporate soil-stratigraphic units into the guide. These units may be the subject of future discussion by the ISSC.*

In preparing a register of Belgian stratigraphical units, the members of the Quaternary Commission were confronted with this void. In general geology, soils are not especially important, but in the Quaternary they are; not the normal superficial soils, but those buried or better still intraformational. Soils represent hiatuses, fill up gaps in the sedimentation and can be more decisive in the stratigraphical interpretation of a succession than the sediments themselves.

My opinion is that the soil, as a fact, should be classed in the lithostratigraphy as a special kind of Bed, with the code Soil, complementary to and independent of the sediment in which it is formed. Its interpretation in terms of the ecosystem responsible for soil formation during a certain time span might be considered as belonging to the realm of biostratigraphy. This pedostratigraphical zonation therefore contributes to chronostratigraphical classification.

Would members of the QRA give their opinion, therefore helping to stimulate discussion at ISSC-level.

Reference

Salvador, A. (ed.) (1994). *International Stratigraphic Guide* (Second edition), IUGS and Geological Society of America, 214pp.

> *ISSC: International Subcommission on Stratigraphic Classification is a subcommission of IUGS International Commission on Stratigraphy, of which the INQUA Commission on Stratigraphy is also a Subcommission.*

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2. THE PRESERVATION POTENTIAL OF ICINGS

Two decades ago the concept of a fossil icing (naled) was first introduced in the British literature by Coxon (1977). This followed an investigation of a fen at Bugg's Hole in Suffolk. Coxon's interpretation attracted no specific comment at the time. In the following year, Taylor (1978) considered such an idea for the origin of hollows in south-west Cambridgeshire but there the complexity of the morphology led her to favour a ground ice thermokarstic origin. Catt *et al.* (1982) described some Dorset downland mounds and enclosed hollows which they interpreted as evidence of former naleds which had later been buried by sediment. Subsequently, Worsley (1986) suggested that the supporting evidence for former naleds at these sites was at best ambiguous and hence felt that the naled hypothesis was unproven. The Bugg's hole site was included by Ballantyne and Harris (1994, p. 82) in their review of large thermokarst depressions but without appraisal. Boreham (1997), has now resuscitated the idea in another East Anglian context.

Numerous anomalous depressions or hollows are known to be associated with cold-stage fluvial sediments in southern England. These occur in three situations: sub-formational, intraformational and supraformational, with the cases described by Coxon (1977) and Boreham (1997) corresponding with the latter. Various mechanisms have been discussed in order to explain these features but no consensus has yet been achieved - see Ballantyne and Harris (1994) for summaries and references. Where depressions occur in the surface of coarse clastic alluvial sequences, usually beneath modern floodplains, they often host lacustrine or similar sediments associated with biogenics indicative of late- and post-glacial age. On the basis of the overlying biostratigraphic evidence it is concluded that the depressions are, therefore, a cold-stage phenomenon. As yet no sedimentological (sectional) evidence has been given to support the interpretation applied to the morphology. As is well known, the concept of equifinality arises where different originating mechanisms lead to similar morphologies. In a periglacial context a recent example of this has been argued by Gurney and Worsley (1997) with respect to a variety of pingos and related landforms in the continuous permafrost of the north-western Canadian Arctic. With this background the objective here is to assess the possibility of buried icing ice being the mechanism of depression formation and to highlight the assumptions involved.

As far as the writer is aware, no modern analogues of buried icings are reported in the literature. This raises the fundamental question of whether icings ever become buried. A similar issue relates to seasonal frost mounds as they are ephemeral features which usually disappear completely during the course of the summer.

Groundwater discharges from taliks appear to be the principal source of water for the development of icings (springs, pingos and glaciers) although overflow of stream water during the freeze-up period is also effective. Personal observations of icings in various parts of the Donjek catchment of The Yukon, northern east Greenland and Spitsbergen, have shown that buried icing is absent, rather the ice aggrades passively **on top** of the alluvial surface. In contrast during the spring - summer melt period the icing can exert a major influence on the position of the newly initiated river channels and induce diversions. Naturally the possibility of buried icing ice is not eliminated by these observations but it is suspected that if it does occur it is on a relatively minor scale.

An often cited paper in the context of icings is the late Stefan Kozarski's (1973) study of orientated kettle holes developed in Polish Late Vistulian (Devensian) glacial outwash sediments. A linear spatial pattern of the hollows led him to postulate that their distribution was controlled by meltwater channel location, and since he felt that ice blocks would only have a limited transport distance from the ice margin, he favoured a periglacial (icing) ice rather than glacier ice origin for the buried ice which was the precursor of the kettle holes. Ironically he was a member of the 1968 Polish Vatnajökull Expedition which made the seminal investigations of Skeidararsandur. If he had been able to revisit Skeidararsandur in the summer of 1997 following the mega flood (jökulhlaup) of November 5, 1996, he would certainly have revised his views on the ice block transport capabilities of glacier-sourced floods as these were to be found in linear belts corresponding to the main meltwater routeways extending across the sandur from the glacier margin to the sea over 25 km away. Such evidence seriously weakens his icing hypothesis in the context of a Polish palaeosandur.

A less well known study is Humlum's (1979) account of icing sedimentary structures. He inferred a mechanism whereby during the disintegration of icing ice on a glacier sandur, minor ridges (0.05 - 0.1 m high and 0.05 - 0.15 m wide and up to 15 m long) were created through the thrusting of collapsing ice blocks. These he felt might have a preservation potential under conditions of low energy, fine sediment aggradation within cut-off channels. Although hypothetically the preservation of these ridges might be possible none has been reported to date.

In conclusion, it is urged that a much more cautious approach be adopted to the interpretation of British enclosed hollow genesis, in terms of icing mechanisms, until syndepositional stratigraphic data are available. Without documentation on the burial of icing ice in modern periglacial environments, the icing concept must remain speculative. In addition it would be helpful for bibliographic searches that the relict nature of the evidence is made clear.

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NOTICES

1. FLUVIAL ARCHIVE GROUP

Future Newsletters (Issue 2 is now available)

All QRA members received the first newsletter of this QRA research group - FLAG News Issue 1, but to receive further issues it is necessary to join the group. Membership is open to all those interested in fluvial sediments. There is no fee.

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2. GEOTOURISM

The GeoConservation Commission, the Geological Survey of Northern Ireland, and the Geological Curators' Group with the support of the Environment and Heritage Service of the Department of the Environment Northern Ireland

announce

a conference to be held in the Ulster Museum, Belfast on April 23rd to 26th, Thursday to Sunday, 1998

Scope of the Conference

- Geotourism and World Heritage Sites
- The Giant's Causeway - a case study
- A recent geotourism project involving the Geological Survey of Ireland and the Geological Survey of Northern Ireland
- Current geotourism initiatives
- Geological and landscape heritage trails
- The history of geotourism
- The literature of geotourism
- Town trails
- Landscape, regional character and sense of place

Papers are invited in these and related areas of interest.

Details of a range of accommodation, and information on cost-effective travel will be made available well in advance of the meeting. It is hoped that the programme will include an evening reception and a conference dinner.

Preliminary planning suggests two days of formal sessions in the Ulster Museum and two excursion days. The excursions will include a visit to the Giant's Causeway and its visitor centre *via* the Antrim Coast Road, and the limestone country of the Fermanagh/Cavan border, for which geotourism literature has been recently developed, this day possibly including a visit to Marble Arch Caves.

For Preliminary Registration and the offer of papers please contact:

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3. INTIMATE

(INTegration of Ice Core, MArine and TErrestrial Records)

Programme 1997-1999

The INTIMATE project, first discussed at the INQUA Congress in Berlin, has now been accepted as a core programme of the INQUA Palaeoclimate Commission. INTIMATE is a successor to the North Atlantic Seaboard Programme of IGCP-253 'Termination of the Pleistocene', and has a broader remit than NASP. The aim of the programme is to synthesise data from the marine, terrestrial and ice-core realms for the North Atlantic region during the course of the Last Termination. Very broadly, the timescale extends from the Last Glacial Maximum (*c.* 25 ka BP) until the early Holocene. It is anticipated that the meetings and workshops to be held over the coming two years will involve scientists from a range of disciplines, and from both Europe and North America. The first meeting was held in Sweden in September 1997 and will be followed by a second major meeting in Atlantic Canada in September 1998. The final meeting will be at the INQUA Congress in Durban, South Africa, in June 1999. It is anticipated that, in addition to these major international meetings, regional workshops will also be held, and one of these is already planned for the British community in April 1998. Details of the programme so far are as follows:

Regional Workshop: One-day INTIMATE workshop to be held at GEOSCIENCES 1998 (Biennial Meeting of the Geological Society)
Date: 9-14th April 1998
Place: Keele, Staffordshire, England
Convenors: J.J. Lowe (London) and M.J.C. Walker (Wales)

International Meeting
Date: September 1998 (dates to be finalised)
Place: Fredericton, New Brunswick, Canada
Convenor: L.C. Cwynar (New Brunswick)

International Meeting: Final meeting of the INTIMATE programme
Date: July 1999
Place: Durban, South Africa
Convenors: J.J. Lowe (London) and M.J.C. Walker (Wales)

Anyone who would like to be involved in the IMTIMATE programme, or who would like to be kept informed of events, should contact either the Co-ordinator of the programme, John Lowe, or the Secretary, Mike Walker, at the addresses below. Please include your e-mail number in any correspondence:

Professor John Lowe
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University of Wales
Lampeter SA48 7ED, Wales, UK
Tel: 01570-424736; Fax 01570-424714
e-mail: walker@lamp.ac.uk

4. GEOSCIENCES '98

Ultra-Rapid Climatic Change and its Signature in the Geological Record

Keele University, 14-18 April 1998

Convenors: G.S. Boulton and J.J. Lowe

Scope of Conference

One of the *Major Symposia* of the GEOSCIENCES '98 programme will be devoted to the above theme. The main focus of this symposium will be evidence

for climatic and environment events which recur at sub-Milankovitch frequencies, particularly those where there is evidence of causes. Of particular interest to the convenors, therefore, will be contributions that present the results of high-resolution studies of recurrent climatic shifts operating at decadal to millennial frequencies and discussion of possible causal mechanisms. A wide spectrum of methods and geographical perspectives will be considered, and it is anticipated that evidence from ice-core, marine and terrestrial records will be represented in the proceedings. The intention is to address such important issues as (i) the quantification of palaeoclimatic interpretations, (ii) closing the gap between the resolution of geological studies and that of the instrumental record, and (iii) developing a predictive capability from geological reconstructions.

Keynote speakers will be:

Professor W. Broecker
Professor J. Jouzel
Professor D. MacAyeal

Registration form(s) for Geoscience '98:

The Conference Office
The Geological Society
Burlington House
Piccadilly
London
WIV 0JU

5. GLACIAL DEBRIS TRANSPORT AND DEPOSITION: PROCESSES AND PRODUCTS

Joint IGS British Branch, QRA, BGRG and BSRG Meeting

School of Geography, University of Leeds, 9-11 January 1998

Scope of the Conference

To provide a forum for the dissemination and development of ideas concerning the manner by which debris is entrained, transported and deposited by glaciers, and how these processes can explain the development of glacial landforms and landscapes. It is hoped that the meeting will bring together glaciologists, sedimentologists, geomorphologists and Quaternary geologists to promote the cross-fertilisation of ideas.

The meeting has support from the International Glaciological Society British Branch, Quaternary Research Association, British Geomorphological Research Group and British Sedimentological Research Group. The conference will take

place between 9-11 January 1998. The first two days will comprise oral and poster sessions, and the third day will be a hands-on workshop on the use of thin-sections in glacial geology and sedimentology. Postgraduate students are especially encouraged to attend. We envisage a publication arising from the conference.

Meeting themes:

- Debris entrainment processes
- Role of structural glaciology
- Basal ice processes
- Deformable beds
- Ice/bed interface
- Water and sediment within and beneath glaciers
- Suspended sediment and bedload and solute transfer
- Role of glaciotectonics
- Sediment transfer to the glaciomarine environment
- Glacial sedimentary facies and facies associations
- Glacial landforms and landscapes
- Ice sheet reconstructions from field evidence

For information please contact:

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or see our WWW page at:
http://www.geog.leeds.ac.uk/conferences/glacial98/glacial.htm

6. SUBCOMMISSION ON EUROPEAN QUATERNARY STRATIGRAPHY (SEQS) SYMPOSIUM

The Eemian – Local Sequences, Global Perspectives

Kerkrade (The Netherlands), 6-11 September 1988

Scope of the Conference

During the 1998 SEQS meeting the first results of the NITG-Eemian Project as well as those of other marine and continental Eemian research projects will be presented and discussed. The meeting will take place in the congresscentre ROLDUC near Kerkrade, in the south of the Netherlands. The provisional cost will be approximately fl. 850.-- (to be specified and confirmed in the second circular). This includes registration, accommodation at the congresscentre, full board, excursion handbook and transport during the excursion.

The proceedings of the meeting with selected papers will be published by NITG-TNO (scientific editors, Dr Th. van Kolfschoten and Dr P.H.Gibbard).

The second circular will be sent in January 1998, the third one (with a review of the programme) will be sent to the participants in July 1998. Participants will be requested to submit the abstracts of the papers and posters before April 1998. The abstracts (preferably in English) will be published in the volume of collected papers.

During this symposium Euromam and EQMal will have their meetings.

Provisional programme:

6 September:	arrival and registration; evening lecture: historical introduction
7 September:	lectures; presentation of regional data
8 September:	lectures; presentation of extra-regional data
9 September:	excursion
10 September:	lectures and posters; presentation of various topics related to the Eemian
11 September:	summarising discussion and departure.

For further information please contact:

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National Geological Survey
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Fax: +31-23-53670647
e-mail: G.Kroon@nitg.tno.nl
Internet: http//www.nitg.tno.nl/eqmal/eem-symp.htm

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.* 1,250) 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 3-4 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 B.M. Funnell***, School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ (e-mail: b.funnell@uea.ac.uk)

Vice-President: ***Dr P.L. Gibbard***, Quaternary Stratigraphy Group, Department of Geography, Downing Place, Cambridge, CB2 3EN (e-mail: PLG1@cus.cam.ac.uk)

Secretary: ***Dr P. Coxon,*** Department of Geography, Museum Building, Trinity College, Dublin 2, Ireland (e-mail: pcoxon@tcd.ie)

Publications Secretary:
Dr S.G. Lewis, Centre for Environmental Change and Quaternary Research, Department of Geography and Geology, Cheltenham and Gloucester College of Higher Education, Swindon Road, Cheltenham, GL50 4AZ (e-mail: slewis@chelt.ac.uk)

Treasurer: ***Dr D. McCarroll,*** Department of Geography, University College Swansea, Singleton Park, Swansea, SA2 8PP (e-mail: D.McCarroll@swansea.ac.uk)

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Dr S. Campbell, Earth Science Division, Countryside Council for Wales, Hafod Elfyn, Ffordd Penrhos, Bangor, Gwynedd, LL57 2LQ

Editor, Journal of Quaternary Science:
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Publicity Officer: ***Dr D.R. Bridgland,*** Department of Geography, Durham University, South Road, Durham DH1 3LE (e-mail: d.r.bridgland@durham.ac.uk)

All questions regarding membership are dealt with by the **Secretary**, the Association's publications are sold by the **Publications Secretary** and all subscription matters are dealt with by the **Treasurer**.

QRA home page on the world wide web at: http://www2.tcd.ie/QRA

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