Since its development in 1949, radiocarbon dating has increasingly been used in prehistoric research in order to get a better grip on the chronology of sites, cultures and environmental changes. Refinement of the dating, sampling and calibration methods has continuously created new and challenging perspectives for absolute dating.

In these proceedings the focus lies on the contribution of $^{14}C$ dates in current Mesolithic research in North-West Europe. Altogether 40 papers dealing with radiocarbon dates from 15 different countries are presented. Major themes are the typo-technological evolution of lithic and bone industries, changes in settlement patterns, burial practices, demography and subsistence, human impact on the Mesolithic environment and the neolithisation process. Some papers also deal with more methodological aspects of $^{14}C$ dating (e.g. calculation of various reservoir effects, the use of cumulative calibrated probability distributions), and related techniques (e.g. stable isotope analysis for palaeodiet reconstruction).

**Philippe Crombé**, **Joris Sergant** and **Machteld Bats** belong to the Archaeology department of Ghent University. They have all been involved for many years in Final Palaeolithic and Mesolithic research, including field-work (survey and large-scale salvage excavations), and laboratory work (techno-typological analysis, GIS, spatial analysis, etc), mainly in the sandy lowlands and wetlands of NW Belgium, but occasionally also in the Netherlands.

**Mark Van Strydonck** and **Mathieu Boudin** belong to the radiocarbon laboratory of the Royal Institute for Cultural Heritage in Brussels. Radiocarbon dating for archaeology and the history of the arts is the main objective of this laboratory, founded in the 1960s. One of the main fields of research in this laboratory is the study of the relationship between the sample and the event (sample selection, integrity and quality on the one hand, event analysis on the other hand).

There exists a long established and close collaboration between the two institutes, which has resulted in joint research projects on dating of Mesolithic pottery food-crusts, antler mattocks, and cremated bones.

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978-1-4438-1421-8
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Sergant, Boudin and Bats

CHRONOLOGY AND EVOLUTION
WITHIN THE MESOLITHIC OF NORTH-WEST EUROPE

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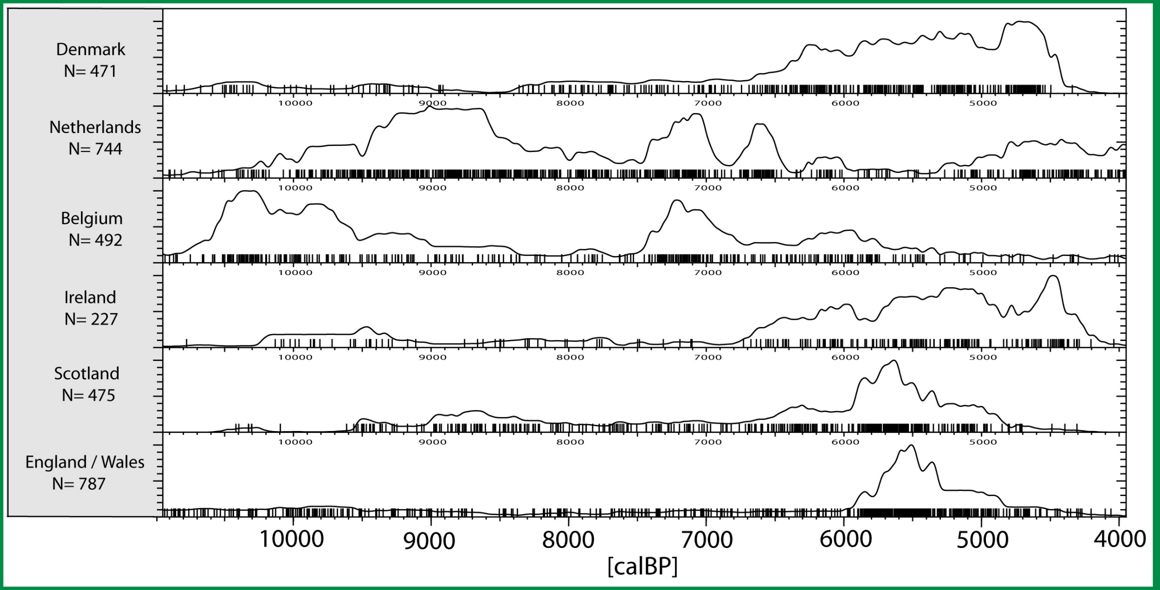
# CHRONOLOGY AND EVOLUTION WITHIN THE MESOLITHIC OF NORTH-WEST EUROPE

## *Proceedings of an International Meeting, Brussels, May 30th-June 1st 2007*

Edited by

Philippe Crombé, Mark Van Strydonck,
Joris Sergant, Mathieu Boudin and Machteld Bats



# CHAPTER THIRTY-ONE

# DATING THE COASTAL MESOLITHIC OF WESTERN BRITAIN: A TEST OF SOME EVOLUTIONARY ASSUMPTIONS

MARTIN BELL, STURT MANNING, NIGEL NAYLING

## Abstract

*Coastal sites in Wales and western Britain provide well-dated sequences for the later Mesolithic 6000-4000 cal BC. Submerged forests are dated by wiggle-match radiocarbon dating of tree-ring sequences. The main sites discussed are Goldcliff East, Westward Ho!, Pembrokeshire sites and Prestatyn. New dating evidence from these sites enables us to test some hypotheses concerning evolutionary development in the late Mesolithic including those concerning sedentism, material culture change and environmental manipulation.*

## Résumé

*Les sites littoraux du Pays de Galles et de l'Ouest de la Grande-Bretagne livrent des séries bien datées pour le Mésolithique récent (6000-4000 cal BC). Des forêts submergées sont datées grâce à la datation au radiocarbone «wiggle-match». Les sites les plus importants qui sont présentés sont Goldcliff East, Wesward Ho!, Pembrokeshire et Prestatyn. Les nouvelles dates provenant de ces sites nous permettent de tester quelques hypothèses concernant des développements évolutifs dans le Mésolithique récent tels que la vie sédentaire, les changements de culture matérielle et l'emprise sur l'environnement.*

**Keywords**: *dendrochronology, radiocarbon, submerged forests, 'wiggle-matching', fire*
**Mots-clés**: *dendrochronologie, dates au radiocarbone, forêts submergées,* wiggle-matching, *feu*

# 1. Introduction

This paper focuses on the contribution of intertidal sites in terms of stratified sequences, precise chronologies, environmental evidence for the role of human agency in the landscape and the implications of this evidence for the general assumption of evolutionary developments within the later Mesolithic. Coastal wetland sites offer a new perspective on the later Mesolithic, a period overwhelmingly dominated by flint scatters from fieldwalking on ploughed land and in upland moors. These scatters are often palimpsests of activity spanning millennia. Mesolithic finds have been made in the submerged forests of western Britain since discoveries in the 1860s at Porlock and Westward Ho! However, the submerged forest sites figure little in syntheses of the period, probably because they have produced quite small artefact assemblages. They are, however, sediment accumulation sites, and phases of activity are stratigraphically separated, with excellent possibilities for dating.

Submerged forests and intertidal peats are widely represented in western Britain; in all 75 sites are known in Wales and immediately adjoining areas of Western Britain (Fig. 31-1). Radiocarbon dates are available for 31 sites. The earliest peats on all but 3 sites date between c. 6500 and 3500 cal BC (Bell 2007, 10). 23 sites have produced Mesolithic or Neolithic artefacts. The Mesolithic of Britain covers some 5800 years from 9600-3800 cal BC. This period saw dramatic environmental change, sea level rose by 60m, the land area in figure 31-1 decreased by 26% and the total length of rivers, which some argue was the basis of territories, declined by 46% (Bell 2007, 327). It should be noted that the changes were most pronounced and rapid in the early Mesolithic and their main effects predated c. 6000-4000 cal BC, the period mainly considered here. Also significant are the effects of population growth, suggested by the greater number of later sites and the fact that they extend to more inland and upland locations (Bell 2007). These factors create a reasonable expectation of significant social change. The literature includes suggestions of greater settling down or sedentism, greater environmental manipulation, and evidence for lithic technological change. Elsewhere in continental Europe, particularly in Denmark, increased complexity is said to be indicated by greater evidence for burials, grave goods and art. The assumption of evolution and increasing social complexity is an important one, not just in understanding the Mesolithic but also the transition to agriculture which some of the identified changes may prefigure. Some assumptions of evolution and increasing complexity will be tested against the most recent evidence from well-dated coastal sites in western Britain.

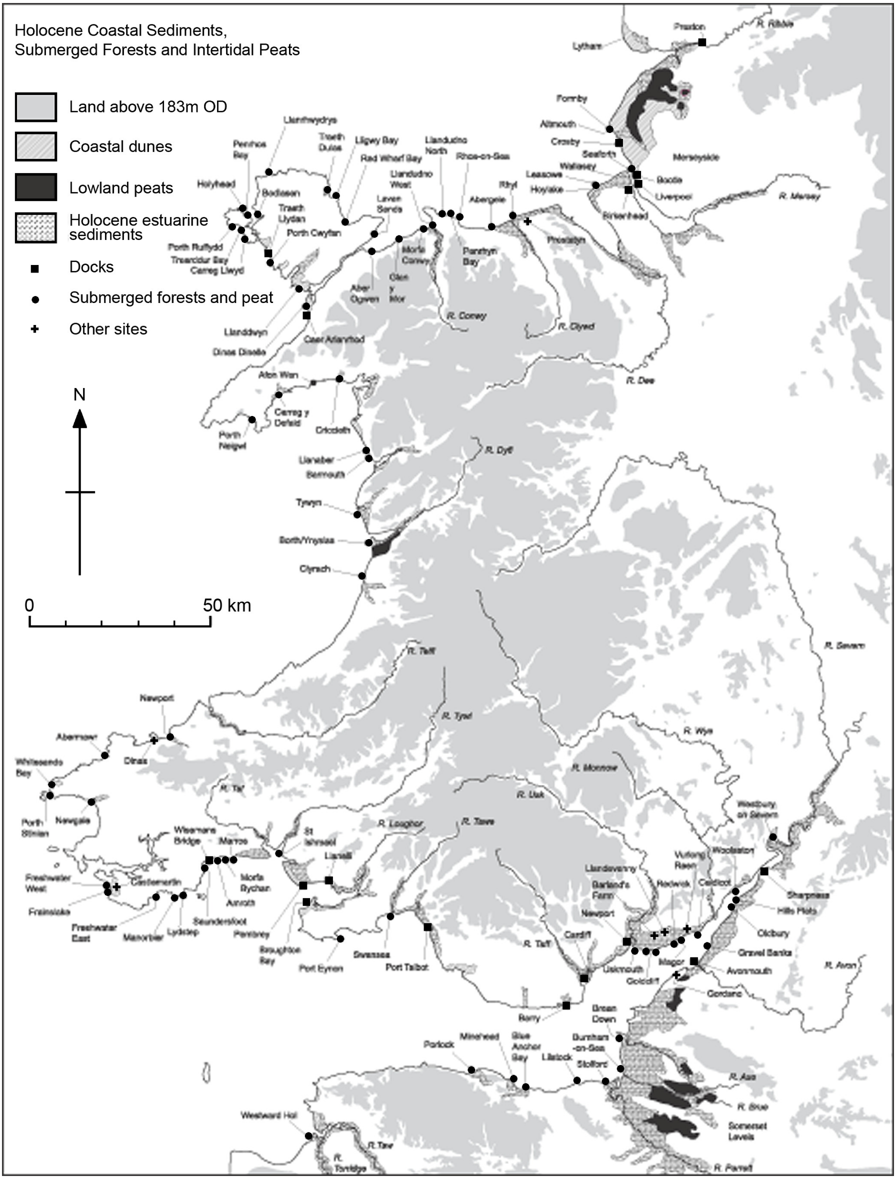



Fig. 31-1: Wales and adjoining areas of western Britain showing the location of the key sites discussed.

## 2. The study area and its stratigraphy

The area considered here is Wales and adjoining areas of western Britain (Fig. 31-1). The evidence for the later Mesolithic in this area has been presented in detail by Bell (2007). The main focus is on the Severn Estuary and particularly excavations at Goldcliff. The Severn Estuary is remarkable in having the second highest tidal range in the world, 14.8m at Avonmouth. The result is a very extensive intertidal zone, 6km wide at Goldcliff during the Lowest Astronomical Tide. The Holocene sediment sequence is 10-15m thick (Allen 2001). The stratigraphy, as typified by the Goldcliff sequence (Fig. 31-2), comprises a basal pre-inundation palaeosol with trees of a Lower Submerged Forest, a thin peat which formed as a result of rising watertables and several metres of laminated estuarine silts forming the Lower Wentlooge Formation. Above this is a thick peat unit with evidence of a reed, fen woodland of the Upper Submerged Forest and raised bog succession and with occasional episodes of silt incursion representing marine transgressive phases. These alternating peats and silts form the middle Wentlooge Formation. Then, from the middle Bronze Age, there is a thick estuarine silt unit, the upper Wentlooge Formation. Here we are particularly concerned with the dating of the Lower and Upper Submerged Forests in the Goldcliff area and the associated archaeological evidence.

## 3. Dating methodology

Mesolithic activity was concentrated between the Lower and Upper Submerged Forest horizons. A key part of the dating strategy was to build up a dendrochronological sequence from the forests. Cross-matched trees formed a site master curve, the general methods employed are those outlined by English Heritage (1998) and the details specific to the sites in question are given in Nayling (2007). It was recognised from the outset that it might not be possible to link these submerged forests into absolutely dated tree ring sequences elsewhere since the radiocarbon dates of the Lower Submerged Forest were earlier than existing dendrochronological sequences from Britain and Ireland. Accordingly from the outset the dating strategy included a programme of high-precision radiocarbon dating at the Heidelberg Laboratory on samples from three of the trees investigated in order to obtain relative dendrochronologically-defined radiocarbon sequences (time-series) from the submerged forests.

These relative time-series could then be compared with, and placed against, the internationally standard absolutely dated radiocarbon time-series available from the northern hemisphere (the radiocarbon calibration curve). This process has come to be called ‘wiggle-matching’, and it allows a relative dendrochronologically-defined

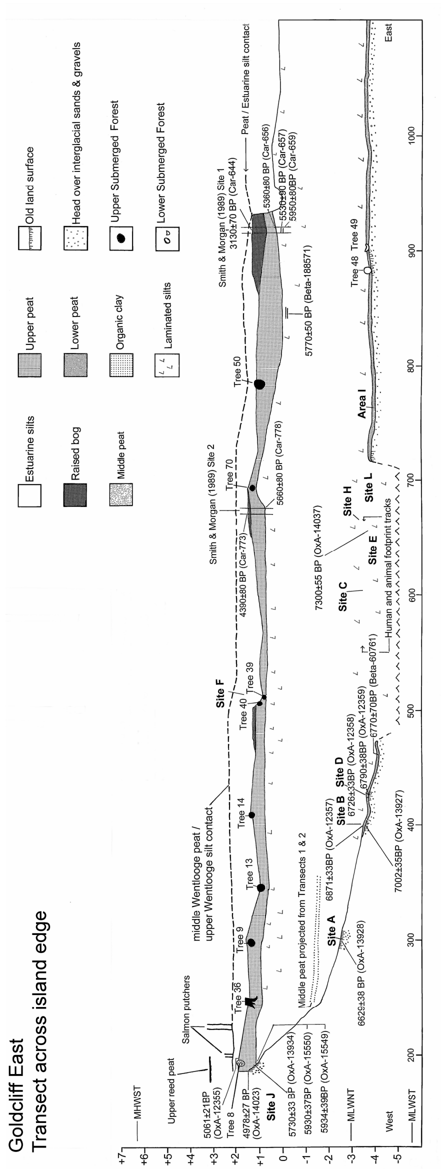



Fig. 31-2: The sedimentary sequence and dated sites at the edge of the former bedrock island at Goldcliff, for details of site dates see table 31-1.

radiocarbon time-series to be placed within narrow margins into calendar year terms (for further explanation and examples of wiggle-matching see e.g. Bronk Ramsey et al. 2001; Galimberti et al. 2004; Manning et al. 2001). One practical issue concerned which of the available calibration curves to use for wiggle-matching. The normal procedure would be to use the latest internationally agreed curve which, at the time of our study was IntCal04 (Reimer 2004). However, as Manning et al. (2007) argue, creation of that curve has involved 5-year averaging and smoothing which is apparently why one of our sequences did not achieve a clear unambiguous match whereas it matched well with the geographically more local British Isles oak data compiled at Belfast. In addition to the submerged forests, radiocarbon dates were also obtained from peat sequences and Mesolithic archaeological contexts. The most detailed dating is available for 2.8km of foreshore subject to detailed archaeological survey at Goldcliff. Here there are 125 radiocarbon dates available from the Holocene sequence of which 64 (51%) relate to Mesolithic contexts and of those 19 relate to wiggle-match dating of submerged forest tree ring sequences (Bell et al. 2000; Bell 2007; Allen and Haslett 2006). The key archaeological dates are given in table 31-1.

## 4. Mesolithic sites at Goldcliff

The Goldcliff sites are situated on the edge of a bedrock rise which, as a result of Holocene sea-level rise, had by c. 5900 cal BC become an island in the midst of saltmarshes and peatlands. The Mesolithic sites were progressively buried by sediment accumulation, creating a well-stratified and dated sequence of occupations (Fig. 31-1). The sites lie between -4.6m OD and +1.5m OD, making excavation challenging because the lowest sites were only exposed at spring tides for c. 1.7hours. The earliest activity is on Site B at the base of the Holocene sequence in the minerogenic soil on which the Lower Submerged Forest grew. This dates to c. 5800 cal BC, roughly when the island formed. Site B activities include human defecation, attested by the intestinal parasites *Trichuris* (Dark 2007), possible plant processing and burning. Nearby Site D had evidence of defecation and burning. Later c. 5700 cal BC, when peat grew over the Site B soil, there was continued evidence for defecation and burning and additional activities included possible skin processing and cooking. Site A was on the early Holocene soil but at a higher level overlain directly by laminated silts. It was occupied c. 5550 cal BC and had the widest range of activities attested including: microlith production and knapping, fish processing and drying, plant processing, butchery and consumption, and skin preparation. The many human and animal footprints in the laminated silts on Sites C, E and H are broadly contemporary with Site A. The

| Site | Date BP | Lab. No. | cal BC | Source |
|---|---|---|---|---|
| Goldcliff, Site A | 6629±38 | OxA-13928 | 5630-5480 | Bell 2007, table 8.2 |
| Goldcliff, Site B OLS | 7002±35 | OxA-13927 | 5990-5790 | Bell 2007, table 8.2 |
| Goldcliff, Site B peat | 6871±33 | OxA-12357 | 5840-5670 | Bell 2007, table 8.2 |
| Goldcliff, Site D, peat | 6726±33 | OxA-12358 | 5720-5560 | Bell 2007, table 8.2 |
| Goldcliff, Site E | 7300±55 | OxA-14037 | 6340-6030 | Bell 2007, table 8.2 |
| Goldcliff, Site J Wood artefact 9199 | 5934±39 | OxA-15549 | 4940-4710 | Bell 2007, table 8.2 |
| Goldcliff, Site J Wood artefact 9224 | 5930±37 | OxA-15550 | 4910-4710 | Bell 2007, table 8.2 |
| Goldcliff, Site W | 6420±80 | Swan-28 | 5520-5220 | Bell et al 2000, 381 |
| Goldcliff, base of upper peat | 5730±33 | OxA-13934 | 4690-4490 | Bell 2007, table 8.2 |
| Westward Ho! earliest charcoal | 8180±150 | HAR-5643 | 7550-6700 | Balaam et al. 1987, table 1 |
| Westward Ho! Charcoal below midden | 6770±120 | HAR-5644 | 5900-5480 | Balaam et al. 1987, table 1 |
| Westward Ho! midden | 6320±90 | HAR-5645 | 5480-5050 | Balaam et al. 1987, table 1 |
| Westward Ho! Oak tree | 6100±100 | HAR-5631 | 5300-4750 | Balaam et al. 1987, table 1 |
| Lydstep pig | 5300±100 | OxA-1412 | 4350-3940 | Lewis 1992 |
| Prestatyn, midden E | 5530±80 | CAR-1420 | 4550-4230 | Bell 2007, table 20.1 |
| Prestatyn, midden D | 5270±80 | CAR-1423 | 4330-3950 | Bell 2007, table 20.1 |
| Prestatyn, midden C | 4890±80 | CAR-1355 | 3950-3500 | Bell 2007, table 20.1 |
| Prestatyn, midden B | 4700±70 | Car-1356 | 3640-3360 | Bell 2007, table 20.1 |
| Prestatyn Human | 4867±38 | OxA-16606 | 3750-3535 | Schulting and Gonzalez 2007, table 20.2 |

Table 31-1: Radiocarbon dates for Mesolithic coastal sites in Western Britain. In most cases only representative dates are given, for other dates from these sites see the source. Dates are calibrated using atmospheric data from Reimer *et al* ( 2004) and Oxcal v3.10 (Bronk Ramsey 2005).

human footprint-tracks are especially notable in having a high proportion of children some as young as 3 to 5, thus demonstrating the active role of children in the lives of this Mesolithic community. The animal footprint-tracks are of red deer, roe deer, aurochs, wolf and many species of bird, including cranes. Identifying activities associated with the footprints is more speculative, they are focused on a palaeochannel and possibilities include fishing, fowling and hunting.

Site W is on the west edge of the former island and was excavated in 1992-4 (Bell et al. 2000). Activity was concentrated here between c. 5700-5200 cal BC and included knapping, butchery and cooking, skinning, fish processing and drying and plant food processing. Site J is on the east side of the former island where occupation on the early Holocene soil included evidence for butchery / skin processing, cooking with heated stones, knapping, sinew processing and a possible small tepee-like shelter. Activity continued as laminated estuarine silts encroached on half the site and knapping is attested. Activity here is dated by two worked wood artefacts, Artefact 9199 comes from the palaeosol (4940-4710 cal BC), Artefact 9224 from the top of overlying estuarine silts (4910-4710 cal BC; Table 31-1). The Upper Peat then started to encroach over this site from c. 4690-4490 cal BC, the highest part of this site being covered by peat c. 3910-3660 cal BC. The Upper Submerged Forest occurs within this peat and its date is discussed below. Activity in the peat was very limited, just a few flakes and some evidence of burning. It appears that for much of the last millennium of the Mesolithic, when the island was no longer surrounded by saltmarsh and mud flats, but by peaty fen woodland, activity occurred on a much reduced scale.

## 5. Dating the submerged forests and laminated sediments

### 5.1 The Lower Submerged Forest at Redwick and Goldcliff

The submerged forest on the pre-inundation surface has been investigated at three sites: Redwick, Gravel Banks and Goldcliff East, of which only the last is associated with a Mesolithic occupation. At Redwick the Lower Submerged Forest was extensively exposed at the time of our fieldwork in 2001 when 111 trees were recorded and sampled for dendrochronology. The recorded trees were large oaks with long straight trunks characteristic of growth in a closed forest and with substantial root buttresses. They had grown on an old land surface developed on Pleistocene sandy gravel head. This was covered by c. 20cm of estuarine silt within which, in association with some trees, was a spread of charcoal, some tree trunks were also charred. Above the estuarine silt was a thin reed peat which covered some trees. 61 trees were cross-matched forming a floating dendrochronological sequence spanning 431 years (Fig. 31-3). Tree 77, the largest of the cross-matched trees, which spans practically the whole Redwick chronology, years 1-428, was selected for radiocarbon dating of 6 decadal blocks (Fig. 31-4a). When matched against the Belfast Chronology for British oaks this gives a date of 6210-6202 cal BC to 5815-5807 cal BC for Tree 77, not allowing for missing sapwood (Manning et al. 2007). The Redwick submerged forest sequence as a whole began at the same date and ends 5782-5774 cal BC, again without allowance for missing sapwood.

At Goldcliff East 41 oak trees were recorded in the Lower Submerged Forest and of these 15 formed a floating dendrochronological sequence which cross-matched with the sequence at Redwick (Fig. 31-3), thus establishing that the earliest trees in the Goldcliff forest began growth 6183-6175 and ended 5830-5822 cal BC, not allowing for missing sapwood. This is at about the time the island formed and the earliest Mesolithic activity took place. Activity continued as thin estuarine silt was deposited across part of the site and with rising watertables a reed peat grew across the former woodland soil and fallen trees.

## 5.2 Dendrochronological links to Gravel Banks and Bouldnor Cliff

The Lower Submerged Forests at Redwick and Goldcliff which cross-match are 4.5km apart. These tree ring sequences also match with submerged forest trees in the bed of the Severn Estuary at Gravel Banks (Fig. 31-4b), 10km away (Tetlow 2005). There is also a match with trees in the permanently submarine forest at Bouldnor on the Isle of Wight in the Solent (Fig. 31-4b), where there is also Mesolithic activity (Momber 2004); this is 140km south-east of the Severn. The cross-matches between these four sites strengthens anticipation that the absolute dendrochronological dating of the submerged forest may one day be achieved. Their drowning would seem to mark a significant marine transgressive episode with consequences for Mesolithic settlements: Bouldnor was drowned, conversely Goldcliff East became an island, the focus of activity for 1100 years. Future research needs to consider the relationship between these changes and the 8.2ka BP event (Alley et al. 1997). The most marked changes of that event appear to be about 400 years before the drowning of the Lower Submerged Forest.

## 5.3 Laminated silts with footprint tracks

The laminated silts at Goldcliff which overlie the basal peat are of particular importance because they preserve footprint-tracks of people and animals. The laminated silts have only one radiocarbon date from Site E (6340-6030 cal BC), but this is on comminuted plant material which in an estuarine context may include reworked material (Bell 2007, 223). Even so, the stratigraphic context of the silts is reasonably well dated. They overlie the Lower Peat dated c. 5650 cal BC and underlie the Upper Peat which started to form c. 4800 cal BC. The main areas of

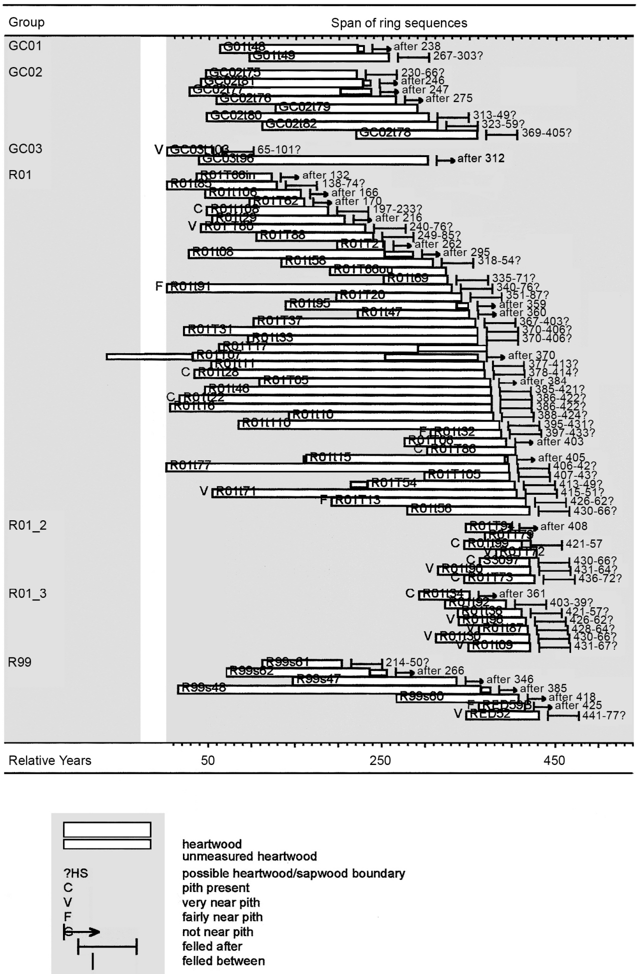
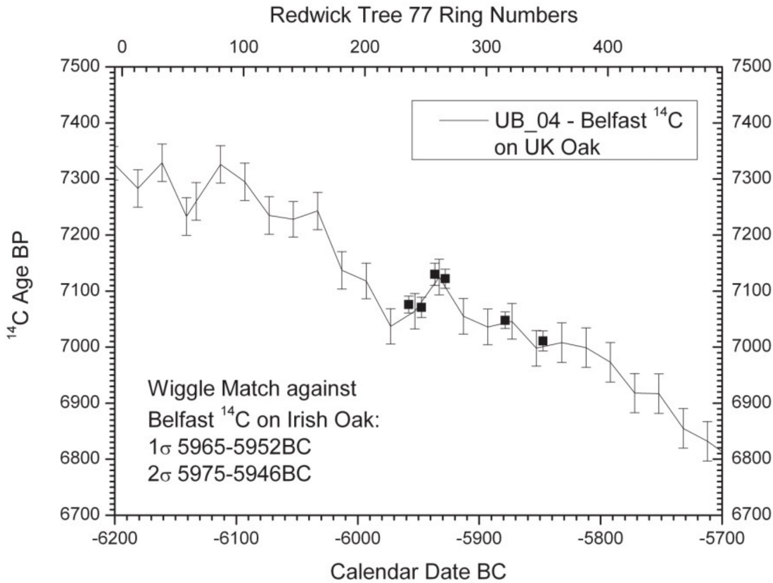



Fig. 31-3: Dating the Lower Submerged Forest: The Lower Submerged Forest tree ring sequence at Redwick and Goldcliff.

footprint-tracks recorded (Sites C, E and H) are in the basal third of the laminated sediments. If we assume the laminated sediments accumulated at a fairly even rate then that would suggest the main areas of footprint-tracks date between about 5650 and 5300 cal BC which is during the period of activity at Sites A and W (Table 31-



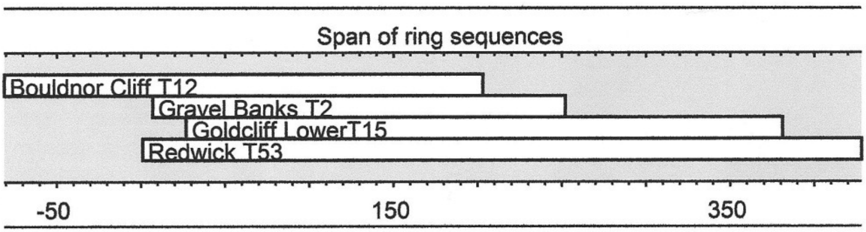




Fig. 31-4: Dating the Lower Submerged Forest: (a. top) Dated samples from Tree 77 plotted against University of Belfast calibration data. (b. bottom) Bar diagram showing the relative chronological positions of cross-matched ring width mean sequences from Redwick, Goldcliff, Gravel Banks and Bouldnor Cliff (T is the number of trees)

1). It has been established by a combination of particle size analysis, sedimentary modelling and pollen analysis that the laminated silts are annually banded, fine clays being laid down in the less turbid, warmer and less viscose waters of summer, coarser silts and sands in the more turbid, cooler and more viscose conditions of winter (Allen 2004; Dark and Allen 2005; Allen and Haslett 2006). This is archaeologically important because it establishes that some of the best preserved human footprints were made in the finest sediment at the height of summer. Microcharcoal deposition in 4 out of 5 years was greater in summer than winter. The annual bands also establish the interval between walks, showing that at times people were present in successive years. It has further been argued that band thickness has the potential to provide a palaeo-climatic record, thus the sedimentary record may one day complement other annually resolved records such as submerged forests (Allen and Haslett 2006). Some deer and aurochs footprint-tracks and one or two poorly preserved human footprint-tracks were also made just before the Upper Peat started to form c. 4800 cal BC.

## 5.4 The Upper Submerged Forest at Goldcliff

The laminated silts gave way to inception of the Upper Peat c. 4800 cal BC with a succession from reed peat to fen woodland within which the oaks of the Upper Submerged Forest became established. 32 of the Upper Submerged Forest trees were sampled for dendrochronology and of these 16 were cross-matched forming a floating chronology of 239 years (Fig. 31-5a). It did not prove possible to cross-match this with previously dated tree-ring chronologies in Britain and Ireland. Tree 36, a stump 50m east of the excavated Mesolithic Site J was selected for radiocarbon dating. It had 188 surviving rings and a sequence of 8 samples was taken for high precision radiocarbon dating which produced the wiggle-match shown in figure 31-5b. Its position on the calibration curve indicates that Tree 36 grew from 4440-4425 cal BC to after 4253-4238 cal BC at 2σ (95.4%) confidence limits. Because Tree 36 forms part of the floating Upper Submerged Forest chronology it can be calculated that the entire chronology spans the period from 4485-4470 (relative year 1) to a date after 4247-4232 cal BC, or allowing for an estimate of sapwood 4208-4193 cal BC.

A substantial oak trunk (Tree 8) 198 years old not allowing for missing sapwood, did not form part of the linked floating tree ring sequence but was of particular significance because it lay within the main sequence of palaeoenvironmental samples. For this reason 5 high precision radiocarbon dates were obtained for a wiggle-match dating exercise, the results are shown on figure 31-5b. This indicates that Tree 8 grew between 4118-4105 and 3920-3907 cal BC and began growth between 87 and 123 years after the death of the latest tree in the Upper Submerged Forest. The chronology from wiggle-matching enables the submerged forest layers to be precisely related to radiocarbon dated pollen sequences through the Upper Peat which formed between 4800 and 1400 cal BC. This establishes to which precise horizon within the pollen sequence the submerged forest relates which, perhaps surprisingly, had been far from clear from previous pollen evidence alone.

## 6. Other coastal Mesolithic sites in western Britain

At Westward Ho! at the mouth of the Taw-Torridge Estuary in the Bristol Channel there is an intertidal land surface with a marine mollusc midden covered by peat and submerged forest (Balaam et al. 1987). Activity on the land surface dates from c. 7000 cal BC. The midden dates between 6000-5000 cal BC and the submerged forest between 5300 and 4000 cal BC. A charcoal spread is associated with the archaeological evidence and in 2002 two charred trees were recorded. Given the composition of the thin midden and two millennia timespan, activity here is likely to represent short-term visits to an ecotonal site from which a range of resources represented in the midden could be exploited, those of the woodland, muddy estuary, rocky shore and sandy shore.

Intertidal sites on the Pembrokeshire coast of Wales were mostly recorded on a small-scale in the early twentieth century (Leach 1918; Wainwright 1963). Seven sites have lithics on surfaces below peats (Abermawr; Amroth; Frainslake; Freshwater West; Lydstep; Newport; and Whitesands). Two sites are of particular note: Frainslake with a possible wood shelter within peat and Lydstep where two microliths were associated with a boar skeleton thought to be a hunting escape and radiocarbon dated 4350-3940 cal BC (Lewis 1992). This is a significant find because it demonstrates microlith use up to the period of the very latest Mesolithic in southern Britain.

At Prestatyn, north Wales, 6 shell middens have been investigated and are dated between 4500-3400 cal BC, thus spanning the final Mesolithic and initial Neolithic (Table 31-1; Bell 2007). The very small size of both the middens and the associated artefact assemblages suggest small-scale and short-term activity with shellfish collecting continuing over the period of a significant ecological change from an open rocky shore with mussels to a prograding sandy shore with cockles and a peat bog developing behind a coastal dune bar.

## 7. Discussion and conclusions

The intertidal sites, particularly the most extensively studied at Goldcliff, are of importance because they overcome many of the limitations of the dryland lithic scatters which overwhelmingly dominate the archaeology of this period in England and Wales. Intertidal sites are well-stratified and provide well-dated sequences with palaeoenvironmental and palaeoeconomic evidence of particular significance for studies of seasonality and plant use. These coastal sequences also enable us to evaluate some of the ideas which have been put forward for evolutionary developments in the later Mesolithic. In continental Europe an increase in burials is

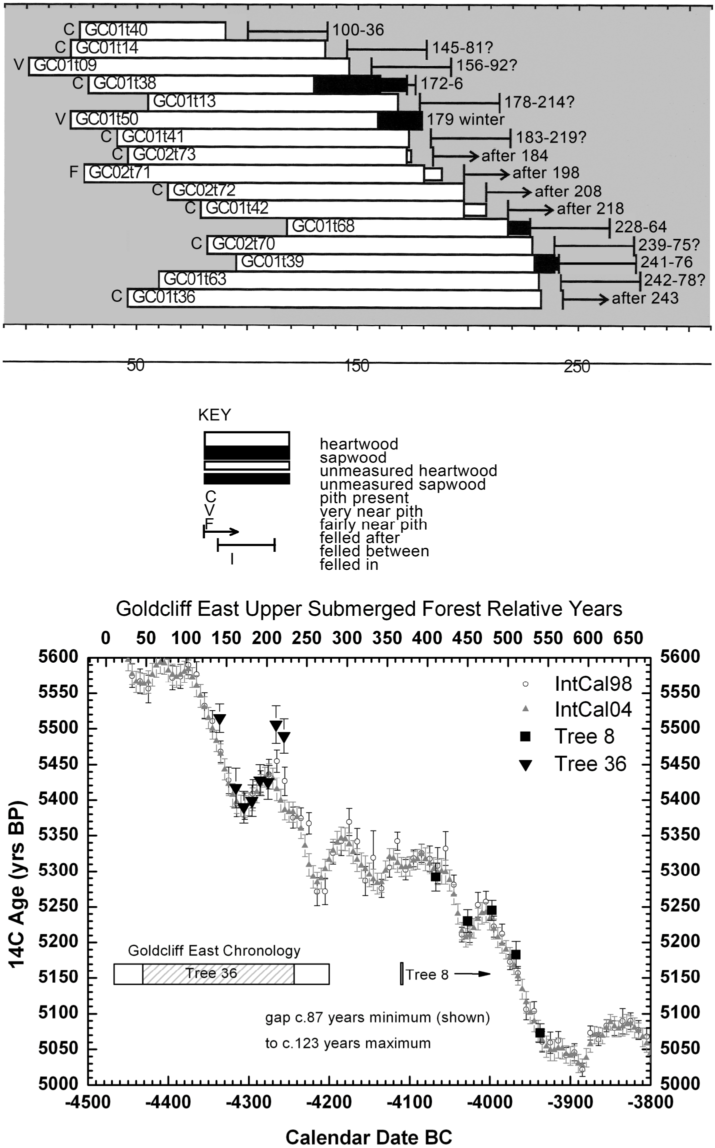



Fig. 31-5: Dating the Upper Submerged forest at Goldcliff East. (a. top) The floating dendrochronological sequence. (b. bottom) Radiocarbon dated samples from Trees 36 and 8 plotted against the Intcal 98 and Intcal 04 calibration data.

seen as evidence of sedentism. In Wales and western England Mesolithic human bones occur in caves, the greatest concentration being at Aveline's Hole at the very beginning of the Mesolithic c. 9120-5520 cal BC (Schulting 2005). None of the human bones dates to the last 1500 years of the period. One burial was found below peat c 400m east of the Prestatyn middens but that was dated c. 3750-3535 cal BC (Table 31-1), thus contemporary with the early Neolithic middens. On the continent burials with grave goods are considered as evidence of increasing social complexity in the late Mesolithic but in this study area the only possible grave goods are from some of the earliest burials at Aveline's Hole (Schulting 2005). Art may also be considered as evidence of social complexity. A decorated horse skull, bovid and deer teeth from Kendrick's Cave, North Wales dates to the Pleistocene / Holocene transition (Aldhouse-Green 2000); geometric designs on the cave wall at Aveline's Hole are likely to date to the period of the early Mesolithic burials (Mullan and Wilson 2005); decorated pebbles at Rhuddlan and a possible figurine at The Nab Head apparently relate to early Mesolithic contexts at both sites (David and Walker 2004). Thus what art we have is early, rather than late, Mesolithic.

One of the developments frequently hypothesised in the Late Mesolithic is increasing sedentism in rich coastal environments (Bonsall et al. 1990; Zvelebil and Rowley-Conwy 1986). In northern Britain there are sites where a reasonable case for sedentism can be made on grounds of multi-season occupancy on Oronsay (Mellars 2004) or substantial house structures e.g. Howick, Northumberland (Waddington 2007). The intertidal and coastal wetland sites noted here do not, however, suggest sedentism. The density of artefacts is low compared to coastal Mesolithic sites in Denmark where the sedentism case is stronger (Andersen 2000); the middens at Westward Ho! and Prestatyn are tiny by comparison. Visits to Goldcliff are thought to be relatively short-term and at various times of year with activity concentrated in autumn (Bell 2007, 242). Activity at Prestatyn seems to have been very short visits, mostly in spring (Bell 2007, 311). There are cliff top sites in western Britain with high concentrations of lithics at Nab Head, Pembrokeshire (David and Walker 2004) and Trevose Head, Cornwall (Johnson and David 1982), but both are in quite exposed situations, perhaps more likely to be autumn aggregation camps relating to seal exploitation than permanent settlements.

Lithic technological change in the late Mesolithic has also been suggested. In Wales it has been argued that flake axe production ceased in the late Mesolithic (David and Walker 2004, 317) and the abandonment of microlithic technology has also been argued in Scotland and is sometimes thought to make the later Mesolithic archaeologically invisible. Goldcliff is one of the latest dated Mesolithic sites in Wales (Burrow 2003). Axe / adzes are present at Goldcliff, but none is stratified, although there are some flakes which may be derived from their production.

Ground stone axes are present at the Nab Head but none are stratified on intertidal sites, although there is a ground stone plaque from Goldcliff (Bell 2007, Fig 9.12). At Goldcliff microliths are well represented, although the latest securely dated artefactual horizon is about a millennium before the end of the Mesolithic. The microliths associated with the Lydstep pig demonstrate clearly that microlithic technology continued to the very end of the Mesolithic.

This brings us to fire as possible evidence for Mesolithic environmental manipulation. Simmons (1996) *'The environmental impact of later Mesolithic cultures'*, suggested that burning increased in the later Mesolithic and was predominantly an upland and moorland phenomenon. In our study area there are 40 sites with possible evidence of Mesolithic environmental manipulation, half of these on the coast below 10m OD. Some sites, like Redwick have no Mesolithic artefacts, but on about a third of sites burning is directly associated with artefacts, as at Goldcliff and Westward Ho!, and on these and other sites trees were burnt; on several Severn Estuary sites including Goldcliff there is also evidence for reed burning (Dark 2007). Although some of the sites must be natural fires, and others hearth charcoal, it is hard to escape the conclusion that there was a strategy of deliberate environmental manipulation using fire which was as, or more, prevalent in coastal contexts as in the uplands. The sites with burning are mostly late, c. 6000-4000 cal BC (Bell 2007, 321). However, there are sites up to two millennia before this and it is significant that coastal sites before c. 6000 cal BC will mostly be permanently submerged. Burning is certainly not restricted to the late Mesolithic, indeed beyond our study area some of the clearest and most detailed evidence for Mesolithic burning is from the very beginning of the period in lowland contexts at Star Carr (Mellars and Dark 1998) and Thatcham (Chisham this volume). A related question concerns pre-elm decline cereal-type pollen which is sometimes associated with burning episodes. In the North-West Wetlands and the Isle of Man it has been suggested that this represents precocious late Mesolithic cereal cultivation (see Innes and Blackford this volume). Our evidence does not support this interpretation. At Goldcliff 'cereal type' pollen is present as early as 5700 cal BC and in Ireland and elsewhere far earlier (O'Connell 1987). A recent survey of dated cereal grains (seeds not pollen) shows that the earliest examples are close to 4000 cal BC (Brown 2007). It is difficult to escape the conclusion that 'cereal type' pollen is derived from wild grasses, which might, or might not, have been encouraged by coastal environmental manipulation. However, their occurrence cannot necessarily be taken as evidence of significant developments in plant use in the later Mesolithic.

The foregoing certainly does not constitute an argument that there was no cultural evolution in the late Mesolithic. What it does suggest is that we have so far failed to assemble convincing evidence to support the frequent assumption of evolutionary developments. Limited evidence from Britain has often been supplemented by the selective borrowing of models from continental Europe. We have noted the drowning of submerged forests on widely separated sites c. 5800 cal BC, however, by that time the main sea-level rise had taken place. The intertidal sites considered here date mainly to the last 2 millennia of the Mesolithic. Evidence of economic and social change in the late Mesolithic has proved difficult to identify and we may also question whether the transition to farming was quite as gradual as prevalent models imply (Thomas 1999; Armit and Finlayson 1992). Continued use of wild plant resources is attested in the Neolithic and continued mobility is hypothesised to explain a paucity of houses. However, the isotopic evidence indicates a marked shift away from coastal resources (Richards et al. 2003), although periodic activity continued on some sites, as Prestatyn shows. As dating is refined, the earliest charred cereals (Brown 2007), chambered tombs (Whittle et al. 2007), causewayed enclosures and pottery seem to occur within a couple of centuries of 3800 cal BC. This may, however, be affected by a bunching of dates between c. 3950 and 3800 cal BC when there is a plateau in the calibration curve. In this way we are presented with an interesting juxtaposition, mirroring debates in both biological evolution and environmental change, between the advocates of gradualism and those placing greater emphasis on contingency and the capacity of societies, organisms or systems to undergo quite rapid transformations even after periods of apparent stasis.

## Acknowledgements

Environmental and dating research was funded by the Natural Environment Research Council (Grant NER/A/S/2000/00490), archaeological excavations by Cadw. We are grateful to colleagues who have collaborated with us in this research: J.R.L. Allen; P. Dark; S. Buckley; C Bronk Ramsey; B. Kromer; S. Talamo; C. Pearson; A. Caseldine; M. Lewis; A. Brown; R. Scales; E. Tetlow, and S. Timpany. Prestatyn was excavated by Clwyd-Powys Archaeological Trust, and thanks are due to its director Bill Britnell and his colleagues.

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