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Finding the coastal Mesolithic in southwest Britain: AMS dates and stable isotope results on human remains from Caldey Island, south Wales

RICK J. SCHULTING & MICHAEL P. RICHARDS*

The implications of new evidence are presented for the generally high level of marine diet in the coastal Mesolithic populations of Wales. Within these generally high levels, some variations may point to seasonal movement. These data provide a strong contrast with the mainland terrestrial diet of early Neolithic populations in the same area.

Key-words: Mesolithic, AMS dates, stable isotope analysis, early Neolithic diet, seasonal movement, Wales

Introduction

It has long been accepted that we will always be hampered in our reconstruction of early and mid-Holocene subsistence and settlement patterns across southern Britain due to the loss of the coastline by inundation. This is unfortunate on a number of grounds, not least of which is that both ethnographic and archaeological evidence strongly suggests that the greatest potential for fisher–hunter–gatherer socioeconomic complexity is typically found among coastal groups. Late Mesolithic developments in southern Scandinavia (Fischer 1995; Pedersen *et al.* 1997; Price 1985) and coastal Brittany (Schulting 1996) provide good examples from a northwestern European context. In Britain, the impetus for understanding coastal Mesolithic lifeways has come primarily from a small number of sites on the west coast of Scotland. In particular, both faunal and more recent isotopic evidence from Oronsay show the high degree of reliance on marine resources on the west coast of Scotland at a point very late in the Mesolithic (Richards & Sheridan 2000; Schulting & Richards in press). But how typical is this of even the coastal Mesolithic economy, at other times and in other parts of Britain? What is the regional and temporal variability in the use of coastal resources during the early/mid-Holocene? Were some groups living year-round on the coast? Or was the coast exploited on a seasonal basis only? In the absence of coastal Mesolithic settlements in southern Britain, such questions have frequently been portrayed as intractable. We suggest here that they are not. The initial results of a research programme on human remains from Caldey Island and nearby mainland sites in south Wales demonstrate the potential of combined stable and radioactive isotopic analyses.

Stable isotope analysis has been used to reconstruct palaeodiet with great success in many parts of the world, particularly in coastal situations (e.g. Chisholm *et al.* 1982; Schulting 1998; Schulting & Richards 2001; Tauber 1981; 1986; Walker & DeNiro 1986). This is because, in the absence of C_4 plants such as maize and millet, the technique easily distinguishes between marine and terrestrial diets, presenting a powerful and *direct* means of addressing the averaged long-term diets of individuals (for reviews, see Ambrose 1993; Schoeninger & Moore 1992). Stable carbon ($\delta^{13}C$) from a purely marine organism will typically give values of about −12 per mil (‰), while Holocene terrestrial organisms will typically give values of about −20‰ (C_4 plants overlap with marine values, but were rare in northwest Europe and need not be considered). Stable nitrogen ($\delta^{15}N$) measures trophic level, and again can distinguish between terrestrial and aquatic (marine and freshwater) ecosystems, since the latter often have longer

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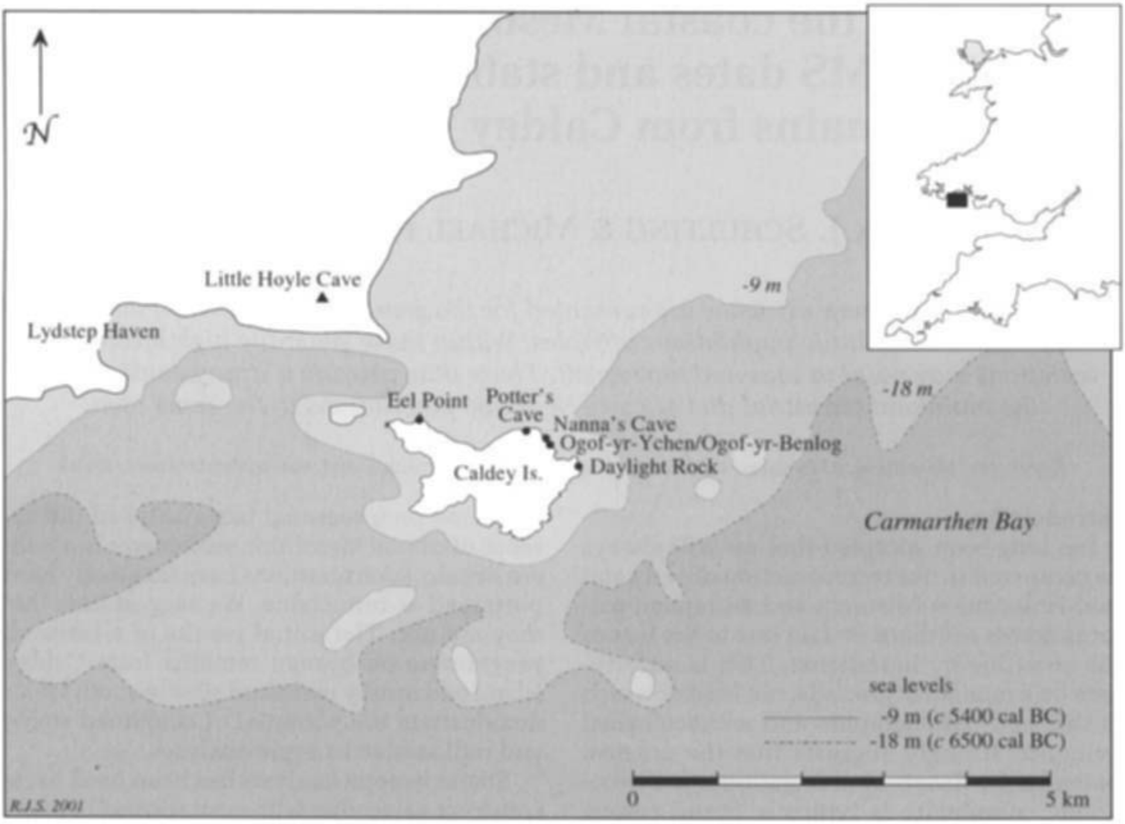

FIGURE 1. *West Carmarthen Bay, south Wales, showing position of Caldey Island and associated sea-levels at 7700 and 6500* BP *(sea-level data from Kidson & Heyworth 1982; Lewis 1992; and Admiralty Chart 1076, Linney Head to Oxwich Point, 2001).*

foodchains. These isotopic differences are maintained from diet item to consumer, and survive in bone collagen.[1] Human bone from individuals that lived near the coast and were exploiting its resources will document that fact. Even scattered and fragmentary human bones, lacking detailed contextual information, from sites that would have been some kilometres from the contemporary coastline, will reveal the use or non-use of marine resources. All that is required is human bone of Mesolithic age from contexts reasonably close to the sea.

Unfortunately, even this requirement is not easily met. Human remains dating to the Mesolithic are notoriously rare in Britain. The relatively well-known sites of the Mendips that have yielded human skeletons (Gough's Cave, Badger Hole, Aveline's Hole) would have been many tens of kilometres inland at the time of their use, and so exploitation of marine resources would not necessarily be expected. This has been borne out by an analysis of three individuals from Aveline's Hole, dating to around 9000 BP, that show no use of seafoods (Schulting & Richards 2000). A more promising series of sites are located on Caldey Island, located off the Pembrokeshire coast in south Wales (FIGURE 1). Throughout the Holocene, Caldey would have been within some 2–4 km of the coast (Kidson & Heyworth 1982; Lewis 1992), and so any individuals using the location in the Mesolithic would have been within a reasonable distance of the sea. A series of excavations concentrating on the northeast corner of the island have over the years revealed a group of sites containing archaeological deposits possibly extending back to the Palaeolithic, and

1 Isotopic measurements of bone collagen reflect only the protein component of the diet, although this is less of a problem in characterizing hunter–gatherer diets in temperate zones, which tend to be high in protein and animal-derived fats.

FIGURE 2. *Brother James van Nedervelde standing at the entrance to Daylight Rock. (Photo courtesy of Tenby Museum, TENBM:48:8.)*

certainly including Creswellian, both earlier and later Mesolithic, and earlier Neolithic materials, as well as a range of later prehistoric and Romano-British remains (Davies 1989; Lacaille & Grimes 1955; Grimes 1951; Leach 1916; van Nedervelde 1975). Of course, a crucial reason for choosing Caldey for this study is that partial and fragmentary human remains were also encountered in each of the sites investigated. Most importantly, one of these had already been shown to date to the Mesolithic, and indeed until recently was the latest dated Mesolithic human from southern Britain (David 1990).

The Caldey Island results

As part of this study, a series of 27 human bone samples was obtained from five sites on the northeast corner of the island: Nanna's Cave, Potter's Cave, Daylight Rock, Ogof-yr-Ychen and Ogof-yr-Benlog, and one site, Eel Point, on the northwest side (FIGURE 2). The Ogof-yr-Ychen and Ogof-yr-Benlog cave systems may have been joined in the past (David 1990). All samples are from adults or adolescents; few could be securely identified to sex due to the types of elements preserved and their incomplete condition. A variety of elements are represented, the criterion being to obtain samples from as many different stratigraphic contexts as possible. The contexts in which these remains were found were largely disturbed, and excavated under less than ideal conditions, so that no secure associations between the human remains and any artefactual evidence can be made. Seven human bone samples were also obtained from Little Hoyle Cave on the mainland across from Caldey, and four from Hay Wood Cave on the western edge of the Mendips; both sites have previously yielded earlier Neolithic dates on human remains (Hedges *et al.* 1993; 1997). As part of a larger on-going project, three samples of previously unknown age were obtained from two sites in south Wales: Priory Farm Cave[2] and Red Fescue Hole. Finally, a limited number of faunal samples from the same archaeological deposits as the human bone on Caldey Island were also analysed. Details of sample preparation and measurement can be found in Richards (1998).

The results for Caldey Island (TABLE 1, FIGURE 3) clearly show the presence of individuals with significantly different diets. C:N ratios and collagen yields serve as a check of the integrity of the bone collagen, and are within acceptable limits. Values for $\delta^{13}C$ and $\delta^{15}N$ are strongly correlated (r^2=0·81), both isotopes demonstrating that some individuals had diets in which a large part of the protein was acquired from marine sources. In particular, all six samples from Ogof-yr-Ychen, representing at least five individuals, reflect considerable use of marine protein. This is in marked contrast to the eight human bone samples from Nanna's Cave, none of which indicate any use of marine resources. The same applies to the single samples from Ogof-yr-Benlog and Eel Point, while the samples from both Potter's Cave and Daylight Rock clearly divide into two groups,

site	sample id.	sex	element	lab no.	date BP	±	date cal BC +2σ	date cal BC −2σ	AMS values (‰) $\delta^{13}C$	AMS values (‰) $\delta^{15}N$	AMS values (‰) % marine	palaeodietary values (‰) $\delta^{13}C$	palaeodietary values (‰) $\delta^{15}N$	palaeodietary values (‰) C:N	palaeodietary values (‰) % marine
Eel Point	1988:30	M?	ulna	OxA-10968	1771	34	AD 134–379		−19·5	9·9	12	−19·7	9·8	3·3	10
Nanna's Cave (NC1)	63.335/61.1		phalanx									−20·5	9·3	3·2	0
Nanna's Cave (NC2)	63.335/61.1		patella	OxA-7740	4520	45	3365	3045	−21·2	9·8	0	−21·7	9·4	3·4	0
Nanna's Cave (NC3)	63.335/61.1		patella									−21·1	9·7	3·2	0
Nanna's Cave	91.9H/4		femur	OxA-7739	4560	45	3500	3100	−21·1	8·7	0	−21·3	9·0	3·1	0
Nanna's Cave	91.9H/7		rib									−21·0	8·1	3·1	0
Nanna's Cave	91.9H/10		rib									−21·4	9·6	3·1	0
Nanna's Cave	91.9H/16		rib									−21·4	9·5	3·1	0
Nanna's Cave	91.9H/15		rib									−21·1	9·0	2·9	0
Daylight Rock	63.336/84·1		mandible	OxA-7686	8655	60	7800	7165	−15·9	13·0	54	−16·2	12·3	3·2	50
Daylight Rock	63.336/84·2		mandible									−20·4	8·8	3·1	2
Daylight Rock	63.336/84·3	M	mandible	OxA-7685	1635	40	AD 263–536					−20·0	7·6	3·1	6
Ogof-yr-Benlog	88.71H/2	F	vertebra	OxA-7743	4660	45	3625	3355	−19·9	10·9	7	−20·1	7·2	2·7	4
Ogof-yr-Ychen YY114	98.2H/142	M	innominate	OxA-7690	8280	55	7350	6710	−15·1	15·1	64	−15·2	15·6	3·2	63
Ogof-yr-Ychen YY115	98.2H/145	F	innominate	OxA-7691	8210	55	7050	6650	−14·4	14·2	71	−14·4	15·0	3·0	72
Ogof-yr-Ychen 'A'	98.2H/1	M?	tibia	OxA-10616	8760	55	7865	7170	−14·6	15·1	69	−14·9	14·2	3·3	66
Ogof-yr-Ychen 'B'	98.2H/14	F?	mandible	OxA-2574	7020	100	5990	5640	−18·3		26	−14·9	15·4	3·1	66
Ogof-yr-Ychen 'B'*	98.2H/54	M	cranium	OxA-7742	7880	55	6740	6405	−15·7	15·6				3·8	56
Ogof-yr-Ychen 'C'	98.2H/179	M?	mandible	OxA-7741	8415	65	7485	7055	−15·9	14·3	54	−16·9	12·9	3·2	42
Ogof-yr-Ychen 'C'	98.2H/36	M?	cranium — possibly same individual as above, but uncertain									−17·2	11·7	3·3	39
Potter's Cave (PC1)	63.337/20		metacarpal	OxA-7687	7880	55	6805	6455	−16·1	12·5	52	−17·5	11·9	3·3	35
Potter's Cave	91.7H/260		radius	OxA-7689	1725	40	AD 236–417		−20·2	10·1	3	−20·3	9·6	3·2	3
Potter's Cave	91.7H/271		rib									−20·0	10·2	2·7	6
Potter's Cave	91.7H/274		rib									−19·7	9·1	2·8	9
Potter's Cave	91.7H/283		rib									−20·1	7·9	2·8	4
Potter's Cave	91.7H/284		rib									−19·8	11·0	2·8	8
Potter's Cave	91.7H/308		ulna	OxA-7688	8580	60	7790	7170	−17·3	11·8	38	−17·3	13·1	2·8	38

Dates calibrated using CALIB 4.3 (Stuiver *et al.* 1998a; 1998b); individuals showing significant contribution of marine foods in diet have been corrected for marine reservoir effect using endpoints of −20·5 and −12‰; '% marine' estimates should be understood as having a ±10% range

Reimer *et al.*'s (2000) ΔR offset of −33±93 years for western British and Irish waters is employed for dates showing marine influence above 10% (see also Harkness 1983)

* the two Ogof-yr-Ychen 'B' samples are clearly not from the same individual; this was already suspected as a possibility (David 1990)

AMS and palaeodietary stable isotope values match reasonably well, with the exceptions of Potter's Cave 63.337/20, Ogof-yr-Ychen 'B' ($\delta^{13}C$), and Ogof-yr-Benlog ($\delta^{15}N$)

TABLE 1. *Stable isotopes and AMS dates on human bone from Caldey Island sites.*

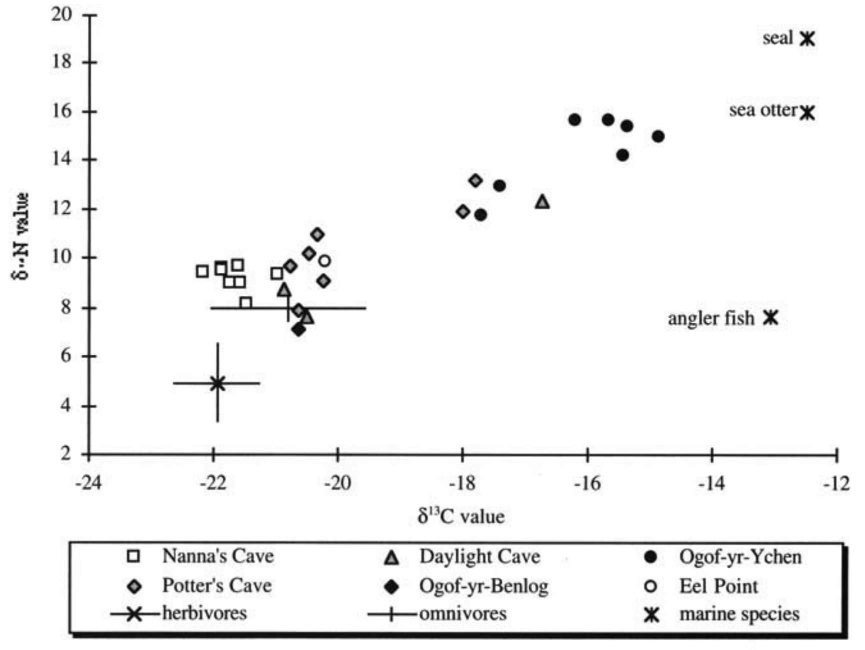

FIGURE 3. *Bivariate plot of stable carbon and nitrogen isotope values on human and faunal remains from Caldey Island sites (seal and sea otter from Oronsay and Oban, respectively). Error bars for herbivores and omnivores show one standard deviation.*

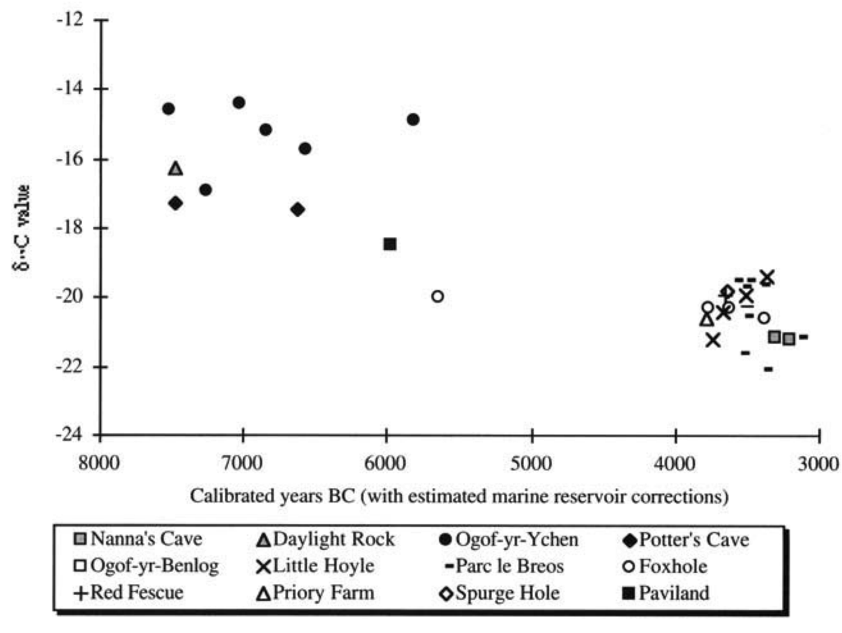

FIGURE 4. *Bivariate plot of stable carbon isotope values and AMS dates on human remains from Caldey Island and other sites in south Wales.*

one of which exhibits an entirely terrestrial diet, with the other showing the use of one-third to one-half marine-derived protein.

We earlier hypothesized (Schulting & Richards 2000: 62) that these differences primarily reflect the date of the human remains and that, consistent with what is known from elsewhere in western Europe outside northern and eastern Scandinavia (Tauber 1981; 1986), those individuals exhibiting elevated $\delta^{13}C$ values would be of Mesolithic age. Those samples demonstrating mixed terrestrial/marine diets (two from Potter's Cave, one from Daylight Cave and two from Ogof-yr-Ychen) are of particular interest, since there is a number of possible interpretations, involving variation within one population at a given time, change through time in the degree of use of marine resources, and/or patterns of seasonal movement. No such precise predictions can be made for individuals exhibiting a terrestrial diet — these could either be Palaeolithic (when marine resources may not have been utilized to any great extent, and the sea would have been at a considerable distance from Caldey even if they were) or Neolithic or later, when domesticated resources came to dominate subsistence in both inland and coastal locations (see below). It is not possible to address the possibility of sex-based differences in diet, since so few of the fragmentary human remains could be assigned a sex — one male and one female identified from Ogof-yr-Ychen have nearly identical isotopic signatures (both are in the strongly marine group).

Fourteen AMS dates were obtained to test the predictions made on the basis of the stable isotope data (TABLE 1, FIGURE 4). Those samples showing detectable marine influence were dated, along with a selection of samples showing purely terrestrial diets. The predictions are borne out very well. *All* of the samples exhibiting a degree of 'marine' influence in the diet proved to be Mesolithic, while *all* dated samples showing 'terrestrial' isotope signatures belonged to later periods (earlier Neolithic and Romano-British). What was unexpected was that the Mesolithic individuals would all be as early as they proved to be. The two earliest human bone dates in the series come from Ogof-yr-Ychen (7865–7170 cal BC) and Daylight Rock (7800–7165 cal BC).[2] These dates lie near the boundary (*c.* 8700 BP; 7900–7600 cal BC) for the Early/Late Mesolithic in Wales as defined by changes in microlith typology, from broad-blade to narrow-blade forms (Aldhouse-Green 2000: 23). Both sites, which are separated by only some 450 m, contain Early Mesolithic microlith assemblages. In the case of Daylight Rock, their age is perhaps better supported by three dates previously obtained on charred hazelnuts from the site (OxA-2245: 9040±90 BP; OxA-2246: 9030±80 BP; OxA-2247: 8850±80 BP; (David 1990; Hedges *et al.* 1994); combined date 8270–7960 cal BC) rather than by the human bone date reported here. On the other hand, the complete absence of any narrow blade microliths (David 1990; Lacaille & Grimes 1955) suggests that the site saw no use in the Late Mesolithic. Late Mesolithic use of Ogof-yr-Ychen is indicated by three geometric microliths from Chamber 2 (David 1990: table 2.10); individual 'C' from this chamber yielded a date of 7485–7055 cal BC. Although no diagnostic microlith forms have been recovered from Potter's Cave, Jacobi (1980) suggested an Early Mesolithic date for the deposits. The two human bones dates (7790–7170 cal BC and 6805–6455 cal BC) fall more comfortably in the earlier part of the Late Mesolithic.

The dates from Ogof-yr-Ychen presented here are all significantly earlier than the date on mandible 'B' of 7020±100 BP (5990–5640 cal BC) reported by David (1990). The latest date in the present series is on cranium 'B': 6740–6405 cal BC. The large discrepancy between the two dates suggests that they do not in fact belong to the same individual. Furthermore, mandible 'B' is quite gracile and may be female, while cranium 'B' is assessed as male. David (1990: 116–17) was aware of this possibility, and proposed that mandible 'B' may actually belong with individual 'A' found lodged head-downwards in 'The Blowhole', a fissure open to the surface. However, a tibia attributed to individual 'A' has now provided the date of 7865–7170 cal BC referred to above, suggesting instead the presence of yet another individual. Dates of *c.* 7000 cal BC on two innominates (a male and a female) are statistically distinguishable from the previous dates and so indicate the presence of another two Mesolithic individuals. Finally, the dated mandible of individual 'C' overlaps with the dates for the two innominates. However, it must represent a different individual, as its dentition is quite worn, whereas the two innominates derive from older adolescents or young adults. This suggests a minimum of six distinct individuals at Ogof-yr-Ychen. The clear separation of the two Mesolithic dates from Potter's Cave indicates that two individuals are represented there. Together with the individual from Daylight Rock, this makes a total of at least nine Mesolithic individuals on Caldey Island (assuming no dated skeletal elements from different sites are from the same individual).

While it may be tempting to infer the existence of a small and rather early Mesolithic cem-

2 The wide range in the calibrated values (all quoted at a 95% confidence interval) is due to a combination of this being a flat portion of the calibration curve, and the increased uncertainties associated with the marine reservoir correction.

etery (although still later than Aveline's Hole) from the Caldey Island dates, it should be emphasized that no individuals are represented by anything approaching a complete skeleton, and it is likely that not all are the result of the formal burial of complete bodies. In common with caves and crevices everywhere, the Caldey sites would have acted as sediment traps into which material would fall or be washed. That being said, caves and crevices are certainly places that attracted intentional burial from the Palaeolithic onwards. Unfortunately, is not possible to resolve which, if any, of the Caldey Island remains represent intentional burials. That at least some may do so receives slight support from the presence of a perforated cowrie shell from Daylight Rock. Such shell beads are often, though not invariably, associated with graves in the Mesolithic of western Europe.

Coastal subsistence, seasonality and settlement

It was anticipated that the samples from Ogof-yr-Ychen showing very high reliance on marine protein (of the order of 60–70%) might fall late in the Mesolithic. In part this follows on from the perfectly reasonable suggestion that the use of coastal resources would have increased from the earlier to the later Mesolithic (e.g, Bradley 1984: 9), both for reasons of improved technology and possible population-resource imbalance brought about, at least locally, by loss of land due to rising sea levels. The data presented here suggest that this is probably not the case. There is no indication that the earlier individuals made less use of marine foods, and indeed a specialized coastal economy seems to have developed at a relatively early stage in the Mesolithic, by the mid 8th millennium cal BC. In a northwest European context, this is comparable to dates for the appearance of intensive marine exploitation in Scandinavia (Bjerck 1995; Wigforss 1995).

This leaves us with what might be seen as a surprising degree of variation in the extent to which marine resources were utilized by groups using Caldey Island in the 8th and early 7th millennia BC (taking the marine reservoir effect into account; *cf.* Schulting & Richards in press). The isotopic values for the five most 'marine' samples (all from Ogof-yr-Ychen) are sufficiently high that it is very probable that the individuals represented were part of a community whose subsistence strategy was focused almost entirely on coastal resources year-round. This need not imply sedentism, but it does argue strongly against seasonal movements between the coast and interior. There is some suggestion from the high $\delta^{15}N$ values on individuals from Caldey Island that higher trophic level species, such as seals, made a significant contribution to the protein component of the diet[3] (TABLE 5). The south coast of Wales has numerous habitats suitable for seal rookeries and, at least initially, these animals would have been easy to take in large numbers (David 1990; Jacobi 1980). Other individuals show a more balanced use of marine and terrestrial resources that could imply seasonal movements; inland groups may have maintained social links with coastal communities allowing them access at certain times of the year. Possible supporting evidence for such interaction comes from a series of inland (*c.* 30 km) Mesolithic sites at Waun Fignen Felen in south Wales on which the most common worked stone is coastal beach flint (Barton *et al.* 1995). It may be that the nature of coastal exploitation changed through the Mesolithic; this is a question that could be addressed in future analyses provided that human remains dating to the appropriate periods can be identified. The terrestrial animal component of the diet is indicated by the standard Mesolithic repertoire of red and roe deer, wild boar and aurochs identified at Ogof-yr-Ychen (Bateman 1973).

A coastal focus for settlement in the Mesolithic is not surprising, and has been inferred from site distributions. In the west of Britain, and particularly in south Wales and England's southwest peninsula, the distribution of lithic scatters indicates a strong preference for what are now coastal locations, and what at the time of their occupation would generally have been cliff edges overlooking a coastal plain of varying extent. Not far from Caldey Island, a substantial Early Mesolithic site — unfortunately lacking in bone preservation — has been recently excavated on Burry Holms just off the Gower Peninsula (Elizabeth Walker pers. comm. 2000). These 'coastal' sites can be very large, covering thousands of square metres, both in Wales (David 1990; Jacobi 1980) and in south-

3 No seal remains have been noted in the fauna examined to date, but more research needs to be undertaken on the collections, which are divided between a number of institutions.

west England (Berridge & Roberts 1986; Johnson & David 1982; Smith 1987). This lends them the character of 'base camps' of some kind, with larger numbers of people staying for longer periods of time (or smaller groups returning repeatedly to the same locations), and with evidence for a wider range of activities. But a coastal focus for settlement and for subsistence are two very different things. The stable isotope evidence presented here suggests that, whatever the details, many of these sites do indeed most likely fit into a settlement system that was for the most part focused on the exploitation of marine resources.

Few samples are presently available that would allow a wider comparison of possible regional differences in the utilization of marine resources in the Mesolithic of southwest Britain (TABLE 2). The relevant five human bone samples derive from Oreston and Kent's Cavern in Devon, and from Foxhole Cave, Paviland Cave and Worm's Head, all on the Gower Peninsula in south Wales (FIGURE 5). The dates span 8100–5700 cal BC, broadly comparable with those from Caldey Island. Unfortunately, some of the associated stable isotope data are problematic. The Oreston $\delta^{13}C$ value is entirely terrestrial, but there may be a problem with contamination (Chamberlain 1996); nevertheless the value is probably broadly acceptable. The Kent's Cavern maxilla was dated at a time when stable isotope values were not routinely measured. A recent attempt to analyse the specimen failed due to insufficient collagen. Greater success was achieved with the Paviland 2 humerus as part of this project, which exhibits only a slight to moderate marine signature, lower than any of the Mesolithic individuals from Caldey Island. A similar value for Worm's Head was obtained through the AMS dating process, although there is some question as to its validity (the specimen is being re-analysed specifically for palaeodietary data).

Perhaps most intriguingly, an isolated human tooth from Foxhole Cave on the Gower Peninsula, recently dated to the later Mesolithic (5730–5560 cal BC), shows no contribution of marine foods in the diet ($\delta^{13}C = -20{\cdot}0‰$) (Richards 2000). This begins to suggest significant variability in the extent to which coastal resources were utilized in the Mesolithic, even by communities living near the sea. The Gower is only some 25 km from Caldey Island, and presumably would

site	sample id.	element	lab no.	date BP	±	date cal BC +2σ	date cal BC −2σ	‰$\delta^{13}C$	‰$\delta^{15}N$	% marine	source
Foxhole Cave, Gower	FX41	tooth	OxA-8316	6785	50	5730	5560	−20·0	11·3	6	Pettitt 2000; Richards 2000
Kent's Cavern	KC 1	maxilla	OxA-1786	8070	90	7320	6690	insufficient collagen			Hedges *et al.* 1989
Oreston	GS 267	clavicle	OxA-4777	8615	75	7940	7520	−20·2		4	Chamberlain 1996
Paviland 2	EM.603	humerus	OxA-681	7190	80	6160	5790	−18·5	10·4	24	Stringer 1986; this study
Worm's Head		ulna	OxA-4024	8800	80	8190	7580	−18·8		20	Hedges *et al.* 1996
							average =	*−19·4*	*10·8*	*13·3*	
							standard deviation =	*0·9*	*0·7*	*10·1*	

TABLE 2. *Mesolithic AMS dates on human bone from south Wales and southwest England.*

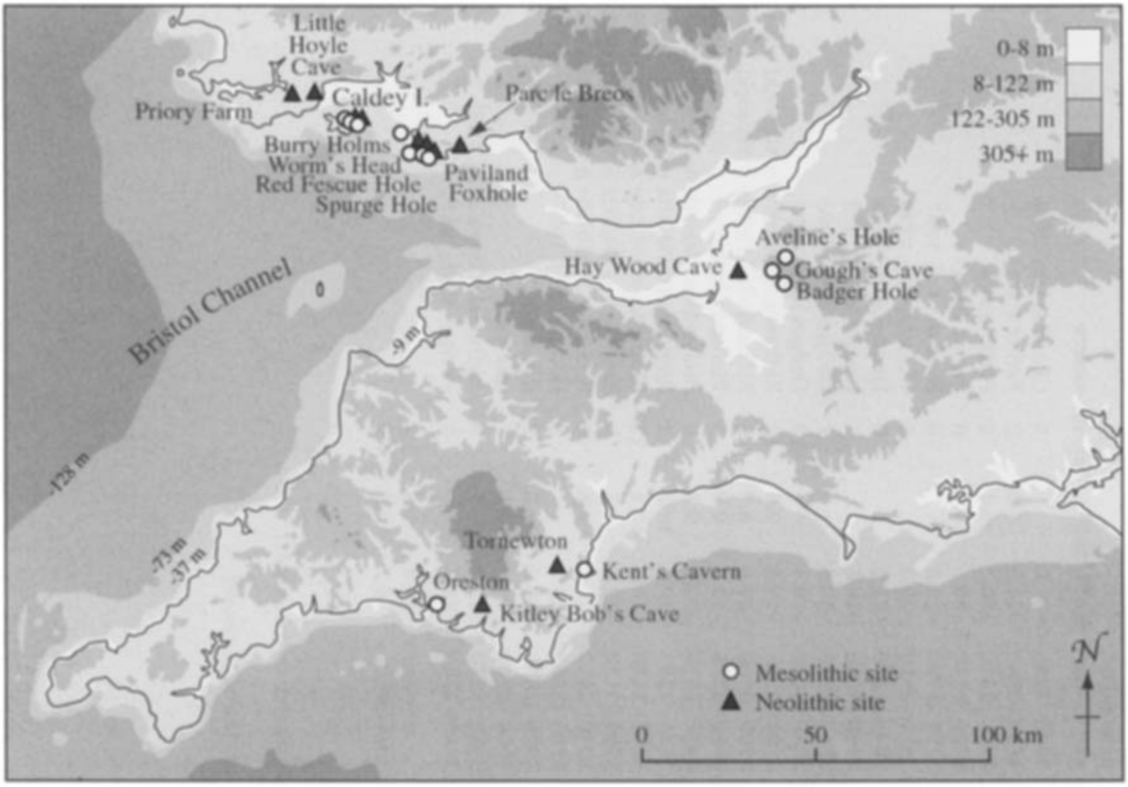

FIGURE 5. *South Wales and southwest England, showing locations of Mesolithic and earlier Neolithic sites discussed in the text. (Drawn by Libby Mulqueeny.)*

have had access to similar resources. There may, however, be some factor in the nature of the contemporary coastline and inshore environment that made marine resources less attractive an option on the Gower. And, as Aldhouse-Green has recently suggested (2000: 27), increasing territoriality may also be a factor at this time. Alternatively, the Foxhole individual may have lived most of his or her life in an inland community but died near the coast. Additional specimens are needed to investigate these possibilities further, and this forms the focus of an on-going project.

A sea-change: the appearance of the Neolithic

The success of the predictions made on the basis of the stable isotope results alone, prior to AMS dating, demonstrates the very real difference between Mesolithic coastal subsistence and that of all subsequent periods. The results are all the more striking in that the Caldey sites would have been much closer to the actual coastline in these later periods. It needs to be emphasized that the equation of 'habitation next to the sea equals use of the sea's resources' is far too simplistic (*cf.* Schulting & Richards in press). This has been recognized for later periods (e.g. Benson *et al.* 1991), and can be observed today for that matter, but the equation continues to be widely applied to our understanding of the Neolithic. Soberingly, Foxhole and other sites demonstrate that such an equation does not always hold even for the Mesolithic period.

There is a surprisingly wide gap of over 3000 years between the Mesolithic dates and the Neolithic dates, both in this study and more generally in Britain (FIGURE 4). The hope of finding Mesolithic individuals post-dating 7000 BP (*c.* 5850 cal BC) has not been realized, and Chamberlain's (1996) comments on the absence of cave burial between *c.* 7000 and 5000 BP in England and Wales are looking increasingly *à propos*. The Foxhole Cave tooth remains one of the very few exceptions. While it is possible that settlements and burial areas at this time

site	sample id.	element	lab no.	date BP	±	date cal BC +2σ	date cal BC −2σ	‰$\delta^{13}C$	‰$\delta^{15}N$	% marine	source
Broken Cavern		tooth	OxA-3206	4885	90	3940	3380	−21.0		0	Chamberlain 1996
Foxhole Cave	FX32	phalange	OxA-8315	4940	45	3890	3640	−20.3	8.6	2	Pettitt 2000
Foxhole Cave	FX177	phalange	OxA-8318	4840	45	3710	3520	−20.3	9.1	2	Pettitt 2000
Foxhole Cave	FX59	tooth	OxA-8317	4625	40	3620	3140	−20.6	9.7	0	Pettitt 2000
Hay Wood Cave	Ind. IV	cervical	OxA-5844	4860	65	3790	3380	−20.8		0	Hedges et al. 1997
Kitley Bob's Cave		femur	OxA-4983	5035	70	3970	3670	−20.3		2	Chamberlain 1996
Little Hoyle Cave	1983.2376/2	mandible	OxA-3304	4930	80	3940	3540	−21.2		0	Hedges *et al.* 1993
Little Hoyle Cave	1983.2435/9	mandible	OxA-3306	4880	90	3940	3380	−20.4		1	Hedges *et al.* 1993
Little Hoyle Cave	1983.2376/11	mandible	OxA-3305	4750	75	3640	3360	−19.9		7	Hedges *et al.* 1993
Little Hoyle Cave	1983.2375/5	mandible	OxA-3303	4660	80	3630	3090	−19.4		13	Hedges *et al.* 1993
Parc le Breos	PA 7932	L humerus	OxA-6496	4850	65	3780	3385	−19.5	9.8	12	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7928	L humerus	OxA-6492	4805	55	3700	3380	−21.6	8.9	0	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7924	L humerus	OxA-6488	4780	60	3660	3375	−19.7	9.8	9	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7927	L humerus	OxA-6491	4710	60	3635	3370	−20.5	9.2	0	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7922	L humerus	OxA-6487	4685	65	3635	3355	−19.5	10.0	12	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7926	L humerus	OxA-6490	4660	60	3635	3140	−19.6	10.4	11	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7930	L humerus	OxA-6494	4645	60	3635	3120	−22.1	9.7	0	Richards in Whittle & Wysocki 1998
Parc le Breos	PA 7925	L humerus	OxA-6489	4445	60	3340	2920	−21.1	9.6	0	Richards in Whittle & Wysocki 1998
Picken's Hole		tooth	OxA-5865	4800	55	3700	3380	−20.7		0	Hedges *et al.* 1997
Priory Farm Cave	09.18/101.4	mandible	OxA-10647	4950	45	3910	3650	−20.6	9.2	0	this study*
Red Fescue Hole	2001.5H/4	fibula	OxA-10649	4880	40	3760	3540	−19.9	10.1	7	this study
Spurge Hole, Gower		femur	OxA-3815	4830	100	3910	3370	−19.8		8	Aldhouse-Green *et al.* 1996
Tornewton Cave		tooth	OxA-5864	4680	60	3630	3360	−21.3		0	Hedges *et al.* 1997
							average =	*−20.4*	*9.5*	*3.8*	
							standard deviation =	*0.7*	*0.5*	*4.8*	

All specimens are fully fused, 'adult' bone
Dates calibrated using CALIB 4.3 (Stuiver *et al.* 1998a; 1998b)
* A second date from Priory Farm Cave, on another human mandible, gave a result of 2300±35 BP (OxA-10648).

TABLE 3. *Earlier Neolithic AMS dates on human bone from south Wales and southwest England.*

were concentrated on the now-submerged coast, this could be expected to apply even more strongly to the earlier Mesolithic, for which there *is* evidence of the deposition of human remains. The dates for the two or three Neolithic individuals from Nanna's Cave and Ogof-yr-Benlog are indistinguishable from one another at *c.* 3400 cal BC, suggesting a period of use of the island for burial in the middle Neolithic (although again these are not complete individuals) that is supported by the presence of Peterborough Ware.

The Neolithic individuals identified from Caldey Island itself are few and belong relatively late in the sequence, several centuries after the appearance of the Neolithic in south Wales. Other sites, however, are available for comparison (TABLE 3; FIGURE 3); all are on or near the coast (within 5 km at the most). Little Hoyle Cave is of special interest, since the site is located on the mainland immediately adjacent to Caldey Island (Green *et al.* 1986). Four dates previously obtained on human bone span the earlier Neolithic (3900–3500 cal BC) (Hedges *et al.* 1993), yet if anything the associated $\delta^{13}C$ values for the two earliest individuals (*c.* –20·8‰) show less indication of a marine signature than the two later individuals (*c.* –19·7‰), although the difference falls just short of statistical significance. These four measurements were obtained as part of the radiocarbon dating process. As part of the present project, stable isotopes were measured separately on a total of seven distinct individuals; again, all show a typical terrestrial diet (TABLE 4), as does a newly dated human mandible (3910–3650 cal BC) from nearby Priory Farm Cave (Grimes 1933).

Parc le Breos Cwm on the Gower Peninsula is often seen as the westernmost example of a Cotswold–Severn chambered tomb; dates on 10 distinct individuals from the monument range 3700–3300 cal BC (Whittle & Wysocki 1998). Stable isotope measurements, specifically for palaeodiet, on these same samples give predominantly terrestrial signatures with no discernible temporal trend (Richards in Whittle & Wysocki 1998). Also on the Gower, human remains from Foxhole Cave (3890–3640 cal BC) (Pettitt 2000), Red Fescue Hole (3760–3540 cal BC) and Spurge Hole (3910–3370 cal BC) are among the earliest directly dated Neolithic human remains in Wales, and again show terrestrial diets. Indeed, the similarity of the isotopic results for these individuals and those from the Parc le Breos chambered tomb suggests little differentiation in diet between individuals placed in monumental and non-monumental contexts. This implies that from the beginning of the Neolithic the diets of entire communities were radically altered, and not just those of a possible 'élite' interred in monuments. A similar observation has been made for the west coast of Scotland, where again no difference could be found between the isotopic values of Neolithic individuals in monumental and non-monumental contexts (Schulting & Richards in press).

Further afield, but still relevant, are earlier Neolithic human remains from southwest England. Sites here include Hay Wood Cave (Everton & Everton 1972) and Picken's Hole in the Mendips, and Kitley Bob's Cave, Broken Cavern and Tornewton Cave in Devon. In the case of Hay Wood, only a single individual has been di-

site	sample id.	sex	element	‰$\delta^{13}C$	‰$\delta^{15}N$	C:N	% marine
Hay Wood Cave	Skull III	M	cranium	–20·8	8·4	3·2	0
Hay Wood Cave	Skull V	F	cranium	–20·9	8·2	3·2	0
Hay Wood Cave	Skull VI	M	cranium	–20·3	9·6	3·2	3
Hay Wood Cave	Skull VII	M	cranium	–20·7	8·8	3·3	0
			average =	*–20·7*	*8·7*		
			standard deviation =	*0·28*	*0·63*		
Little Hoyle Cave	1983:2375	I	mandible	–20·4	8·4	3·4	1
Little Hoyle Cave	1983:2376.A	I	mandible	–20·2	9·6	3·3	4
Little Hoyle Cave	1983:2376.B	M?	mandible	–21·1	8·0	3·4	0
Little Hoyle Cave	1983:2376.C	I	mandible	–20·6	8·6	3·2	0
Little Hoyle Cave	1983:2376.6	I	mandible	–21·6	8·1	4·0	0
Little Hoyle Cave	1983:2376.7	I	mandible	–21·4	7·9	3·4	0
Little Hoyle Cave	1983:2380.1	M?	mandible	–20·5	8·5	3·3	0
			average =	*–20·8*	*8·5*		0
			standard deviation =	*0·52*	*0·57*		

TABLE 4. *Stable isotope values on human bone of probable Neolithic age.*

site	sample id.	element	species, Latin name	common name	‰$\delta^{13}C$	‰$\delta^{15}N$	C:N	% marine	source
marine species									
Oronsay			*Halichoerus gryphus*	grey seal	−11·9	19·1	3·5	100	Richards & Mellars 1998
Carding Mill Bay, Oban	C VI:21	mandible	*Lutra lutra*	sea otter	−12·0	16·0	3·2	100	Schulting & Richards in press
Potter's Cave	1983:2521	vertebra	*Lophius piscatorius*	angler–fish	−12·6	7·6	3·0	94	this study
				average=	*−12·2*	*14·3*			
terrestrial species, omnivorous									
Potter's Cave	1983:2527.A	mandible	*Canis* sp.	Canid, dog?	−19·8	8·0	3·4	8	this study
Potter's Cave	1983:2527.A	mandible	*Canis* sp.	Canid, dog?	−20·4	8·1	3·4	1	this study
Little Hoyle Cave	1983:2381.4	ulna	*Canis* sp.	Canid, dog?	−21·6	7·7	3·3	0	this study
Eel Point	1983:2577.A	mandible	*Sus scrofus*	wild boar	−18·5	8·6	3·3	24	this study
Little Hoyle Cave	1983:2437.1	long bone	*Sus* sp.	domestic? pig	−21·2	7·2	3·4	0	this study
				average =	*−20·3*	*7·9*			
terrestrial species, herbivorous									
Eel Point	1983:2613	antler base	*Cervus elaphus*	red deer	−20·5	4·4	3·3	1	this study
Eel Point	1983:2580	hoof	*Cervus elaphus*	red deer	−21·8	5·4	3·3	0	this study
Ogof–yr–Ychen	Y41	mandible	*Cervus elaphus*	red deer	−22·3	2·4	3·1	0	this study
Little Hoyle Cave	1983:2439.2	femur	*Ovis/Caprus* sp.	sheep/goat	−20·9	5·0	3·3	0	this study
Little Hoyle Cave	1983:2384.6	metapodial	*Ovis/Caprus* sp.	sheep/goat	−20·8	5·1	3·2	0	this study
Little Hoyle Cave	1983:2441.3	long bone	*Bos* sp.	cattle	−22·2	5·6	3·2	0	this study
Little Hoyle Cave	1983:2441.1	mandible	*Bos* sp.	cattle	−22·2	6·3	3·4	0	this study
Nanna's Cave	1983:2589.A	humerus	*Bos* sp.	cattle	−21·2	7·3	3·2	0	this study
Nanna's Cave	1983:2589.B	calcaneous	*Bos* sp.	cattle	−21·2	2·8	3·7	0	this study
				average =	*−21·4*	*4·9*			

The fauna is assumed to be contemporary with the predominantly Mesolithic/Neolithic dates from these sites
The $\delta^{15}N$ values for two of the *Bos* sample are unusually high; this needs further investigation

TABLE 5. *Stable isotope values on faunal remains from Caldey Island and west Scotland.*

rectly dated (3790–3380 cal BC) (Hedges *et al.* 1997), while four additional individuals have been analysed for stable isotopes. Single human elements from the remaining sites have been directly dated to the earlier Neolithic. As with Little Hoyle and the Gower sites, samples in this group show no appreciable use of marine foods (TABLES 3 & 4).

Interestingly, a few values of around –19·5‰ could indicate some minimal input of marine protein (of the order of 5–10% of the protein component) in the diet of some individuals at Little Hoyle Cave, Parc le Breos Cwm and Spurge Hole. But this is of another order entirely from the degree of marine food consumption seen in the Mesolithic on Caldey Island, as high as 60–70% for some individuals. Perhaps more importantly, no trend can be detected, either at Little Hoyle or at Parc le Breos Cwm, for any gradual change in subsistence from a more 'Mesolithic' diet (i.e. one including seafoods) in the Early Neolithic to a more 'Neolithic' diet in the Middle Neolithic. It may be that such a transition did take place in the few centuries prior to *c.* 3800 cal BC, but since human remains are as yet unknown in this area from the critical period between 4500 and 4000 cal BC, this possibility must remain open for future investigation: on present evidence it seems unlikely.

Summary

Although based on a relatively small number of samples, largely from scattered and uncertain contexts, the results obtained here demonstrate that it is possible to approach aspects of the coastal Mesolithic subsistence economy in southern Britain. More than this, inferences can be made concerning settlement and seasonality. The most marine values from Ogof-yr-Ychen must reflect individuals who spent the majority of their lives by the sea, and who focused predominantly on marine resources for subsistence. At the same time, results from other individuals from Ogof-yr-Ychen, Daylight Rock and Potter's Cave seem to show that some groups, or at least some individuals, followed a subsistence strategy using marine and terrestrial resources more equally, or even favouring the latter. An element of seasonal movement between the coast and the interior is a distinct possibility for this group. An interesting question then becomes the relationship between these two groups, and whether they were truly contemporary, as the dates seem to suggest. If variation within a single population is invoked, then it is likely that such groups were focused largely on the coast, since this is necessary to account for the more extreme marine values seen. Further complexity is suggested by a number of individuals from sites on the Gower and in southwest England that seem to show minimal use of marine foods.

While no final Mesolithic individuals were identified, the isotopic analysis of a number of coastal and near-coastal humans from the Early Neolithic shows that a major shift in the subsistence economy took place, apparently from the very beginning of the Neolithic (*cf.* Richards & Hedges 1999). There is only the slightest hint of the use of marine resources after the beginning of the 4th millennium BC; whether individuals derive from monumental or non-monumental contexts does not seem to make any difference in this regard. Thus, if we can make the reasonable assumption that the exploitation of marine resources continued into the Late Mesolithic with at least the same intensity as seen in the earlier part of the Mesolithic, it is clear that the appearance of the Neolithic saw a sharp shift in economic practice in at least some areas. Nor should this be seen in isolation; such a shift would of course have affected all areas of life, from settlement patterns to community structure and organization, and no doubt to worldview as well.

Further work is currently being undertaken around the coast of Wales in order to investigate spatial and temporal patterning both within the Mesolithic, and in the process of neolithization. Isotopically, the Neolithic side of the equation already seems reasonably clear, and what is really needed is a better understanding of the entire span of the Mesolithic, but particularly the later Mesolithic.

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