Dating Women and Becoming Farmers: New Palaeodietary and AMS Dating Evidence from the Breton Mesolithic Cemeteries of Téviec and Hoëdic

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Dating Women and Becoming Farmers: New Palaeodietary and AMS Dating Evidence from the Breton Mesolithic Cemeteries of Téviec and Hoëdic

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This paper presents and discusses the results of a palaeodietary and AMS dating study of burials from the Mesolithic sites of Téviec and Hoëdic, Brittany, France. In common with other Mesolithic coastal populations in Europe, isotopic analysis demonstrates the significant use of marine resources by the sites' inhabitants. Greater interest, however, is provided by the inter- and intrasite details of the analysis. There is an unexpected difference between the two sites, with the inhabitants of Hoëdic deriving 70 to 80% of their protein from the sea, while the inhabitants of Téviec appear to show a more balanced use of marine and terrestrial protein. At the intrasite level, women, and particularly young women, were found to exhibit less use of marine foods. It is suggested that this could indicate an exogamous, patrilocal marriage pattern, with some women marrying in from more inland communities. The AMS dating program shows that the sites were roughly contemporaneous but were used for burial over a longer period of time than originally anticipated. Two cases could suggest the reuse of graves after the passage of centuries, a practice more typically associated with Neolithic passage graves. Unresolved issues remain surrounding the calibration of the dates, complicated by the inclusion of marine protein in the diet, but even before correction for this effect a number of dates overlap with the earliest Neolithic of the region. This raises a number of possible scenarios for the Mesolithic–Neolithic transition in Brittany.

INTRODUCTION

The Mesolithic–Neolithic transition in western Europe has been the focus of many recent studies, forming the focus of a lively debate over not only how the transition is to be explained but also how the terms themselves are to be defined (e.g., Ammerman and Cavalli-Sforza 1984; Armit and Finlayson 1992; Blankholm 1987; Bradley 1997; Hodder 1990; Jennbert 1994; Lubell et al. 1994; Price 1996; Price et al. 1995; Rowley-Conwy 1995; Rozoy 1989; Schulting 1998a, 1998b; Sherratt 1995; Thomas 1988; Tilley 1996; Zvelebil 1998). Certain areas of northwest Europe, and in particular southern Scandinavia, have to some extent dominated these discussions, understandable in light of the wealth of information and often excellent preservation conditions there. But other parts of western Europe may have experienced substantially different trajectories; in many ways the Ertebølle culture of culture of southern Scandinavia is unique, although this itself may be a view conditioned by the survival there of the Atlantic period coastline. Nevertheless, as our models of the transition multiply, in large part due to the advent of new theoretical perspectives, the need for new data to help choose between

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them is becoming increasingly apparent. Two of the major issues to be addressed concern the role of subsistence change across the transition and the timing of the process itself. Revisionist positions have questioned the importance of novel resources (Dennell 1983) in the subsistence economy of the earlier Neolithic, arguing instead that traditional resources continued to dominate day-to-day subsistence. In this respects and others, the transition is being viewed by some researchers as a long, drawn-out affair, with continuities being emphasized over discontinuities (e.g., Tilley 1996; Whittle 1996).

Brittany is another key area in discussions, both of the nature of late Mesolithic society, and of the Mesolithic–Neolithic transition. But, in the absence of the Atlantic period coastline, the quality of the evidence is not on par with that of southern Scandinavia. This makes it particularly important to utilize fully the material that is available in order to shed light on this watershed in European prehistory. Undoubtedly the two most significant Mesolithic sites in Brittany are the shell middens of Téviec and Hoëdic, presently located on small islands off the coast of the *départment* of Morbihan in southern Brittany (Fig. 1). Téviec and Hoëdic were excavated in the earlier half of this century by the Péquarts (Péquart et al. 1937; Péquart and Péquart

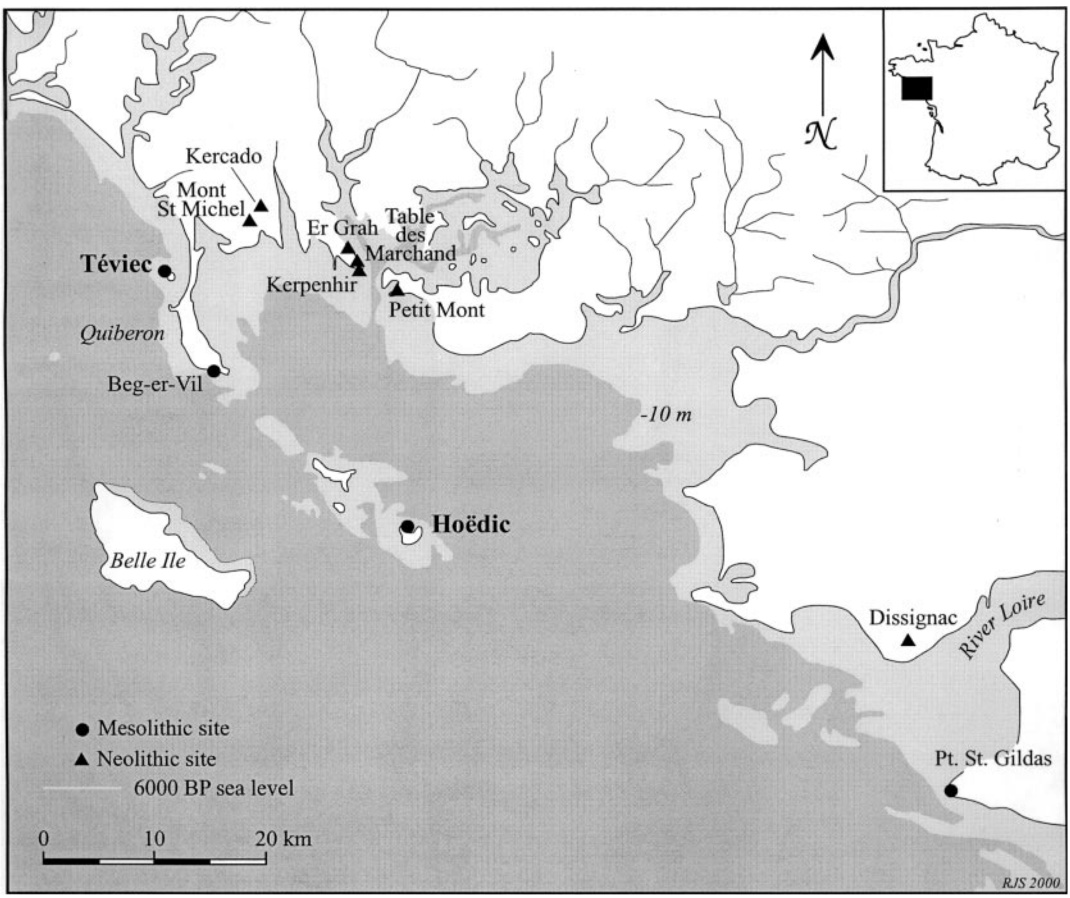

FIG. 1. Map of the Bay of Quiberon showing locations of Téviec and Hoëdic and other selected sites mentioned in the text, together with postulated sea level at ca. 6000 B.P. (after Ters 1973).

1929, 1934, 1954). Their importance lies mainly in the presence of a series of human burials at each site. Despite the passing of over half a century, no comparable surviving sites have been found in Brittany, although a number of notable discoveries have been made (e.g., Kayser 1985, 1991; Kayser and Bernier 1988; Le Roux 1985).

Téviec and Hoëdic are crucial sites for a number of reasons. Geographically, they bridge the gap between the better known Mesolithic coastal cemeteries of southern Scandinavia and Portugal, and they are relevant to discussions concerning the development of social complexity in the late Mesolithic of Atlantic Europe. They must also figure prominently in any discussion of the transition to the Neolithic in Brittany. Téviec in particular has been widely cited as a possible precursor for the well-known megalithic tombs of the Breton Neolithic (e.g., Case 1976; Scarre 1992). Yet, despite their importance, two crucial aspects of the sites have remained unclear, their absolute age and the subsistence economy of the inhabitants. Both issues are substantial in their own right, but they are also inextricably linked by the nature of a defining characteristic of the Neolithic as involving a degree of reliance on novel domesticated resources (e.g., Zvelebil 1998). This paper presents the results of a program of stable isotope analysis for the purposes of dietary reconstruction and accelerator dating on human bone from Téviec and Hoëdic (the latter reported in preliminary form in Schulting 1999). The findings are discussed in relation to the Breton Mesolithic and in the wider context of the transition to the Neolithic.

SITE BACKGROUND

Téviec and Hoëdic are best known for their relatively elaborate graves, including single, double, and multiple interments, some of which, associated with simple stone cists, are clearly successive in the same tomb (Fig. 2) (Péquart et al. 1937; Péquart and Péquart 1929, 1934, 1954). What have been interpreted as large ritual hearths, typically containing red deer and boar mandibles, were found immediately above a number of the graves. Grave inclusions, particularly in the form of marine shell beads and red deer antlers, were also numerous (Fig. 3) (Schulting 1996a). The 10 graves found at Téviec held the remains of some 23 individuals; a structure identified as a cenotaph was also present (Péquart et al. 1937:59). Nine graves were recovered from Hoëdic, containing 14

FIG. 2. Hoëdic during excavation (Péquart and Péquart 1954: Plate V, Fig. 2).

FIG. 3. Grave K from Hoëdic (Péquart and Péquart 1954: Plate V, Fig. 1).

TABLE 1
Demographic Data for Téviec and Hoëdic

Age / sex class	Téviec	Hoëdic
Infant (·0 to 2 years)	6	3
Child (>2 to 12 years)	2	2
Younger adult (<35 yrs)		
Male	4	2
Female	8	3
Older adult (>35 yrs)		
Male	2	2
Female	1	2
Total	23	14

Note: Adolescent is combined with young adult here since only one adolescent was recognized, from Téviec; age assessments are based on personal observation for some specimens and on information in the original publications as well as in Newell et al. (1979); the sex of skeleton No. 2 from Grave B at Téviec, identified in Péquart et al. (1939) as a young adult male, is here presented as young adult female, reflecting a reassessment suggested by Newell et al. (1979:133) and supported by personal observation (R.J.S.).

individuals (a 10th grave was assumed to have contained a child based on its size, although no skeletal remains were preserved) (Table 1). While it has long been clear from their lithic assemblages that both sites date to the later Mesolithic (Marchand 1999; Péquart et al. 1937; Péquart and Péquart 1954; Rozoy 1978), a more precise placement within this period has been lacking, particularly in light of the large standard error and uncertain associations of the single available radiocarbon date from Hoëdic (GIF-227: 6575 ± 350 B.P. (Delibrias et al. 1966), calibrating to 6060–4770 B.C. at two standard deviations) that has until now provided the best assessment of the date of both sites.[1] Aside from the very large standard error of this estimate, the relationship of the charcoal sample to the burials has never been clear. Stratigraphically, Téviec at least appears to have been in use both before and after its use as a burial place. Nor has it been possible to place the sites relative to one another. They are clearly of roughly the same age, but it is possible, for example, that they were used sequentially rather than simultaneously. Indeed, based on differences in the percentages of various types of microliths, Rozoy (1978) proposed that Téviec could be slightly later in date than Hoëdic. Finally, the relationship of the sites to the earliest Neolithic of Brittany has remained problematic.

Little information remains that would permit a reconstruction of the economy of the sites' inhabitants. Although the sites are shell middens (in the case of Téviec some 0.5 to 1 m deep, and in the case of Hoëdic 0.3 to 0.5 m) and are presently being eroded into the sea, they were at the time of occupation some distance from the coast. The faunal remains were reported only in minimal fashion, but they appear to have been dominated by the usual suite of large mammals found on western European Mesolithic sites, red deer, roe deer and wild boar. Beaver and a number of fur-bearers were also present, as were more than 15 bird species (Péquart et al. 1937:101–02). Recovered plant remains were limited to carbonized hazelnut shells and pear pips. Shellfish were abundant and dominated by mussels, cockles, winkles, limpets, and oysters. Despite the lack of sieving, the remains of fish, most likely ballan wrasse (*Labrus bergylta* Ascanius), were noted as being plentiful at Téviec; unidentified fish remains were noted for Hoëdic. Sea mammals are represented only by a few seal teeth and whale bones, the latter probably scavenged. Both the faunal remains and cursory site territory analysis, then, suggest that terrestrial foods may have actually dominated the diet. A single purported sheep's tooth (subsequently lost) from Téviec and possible cattle bone fragments from Hoëdic have been used to infer either a pastoral element to the economy or contact of some kind—even if only the hunting of feral animals—with Neolithic communi-

[1] A sample of "ashy earth" from Téviec resulted in a determination of 2230 ± 150 B.P. (GsY-196) (Giot 1963), which, whatever it refers to, is clearly not relevant to either Mesolithic or Neolithic use of the site.

ties (see brief discussion in Schulting 1996a). But the evidence is slight and recent attempts to reanalyze the finds have been thwarted by difficulties in locating the faunal material (new information indicates that some material is still extant in museums (Tresset, personal communication 2000), and the reexamination of this material will form one aspect of future research).

Both the dating and the subsistence economy of these groups are thus poorly understood, and it was with the intention of addressing these aspects of the sites that the present study was undertaken.

ANALYSIS

Since it directly reflects past diet, stable isotope analysis has some distinct advantages over traditional archaeological approaches to palaeodietary reconstruction (see reviews by Ambrose 1993; Schwarcz and Schoeninger 1991; Schoeninger and Moore 1992). Stable isotope analysis of human bone collagen provides information on sources of dietary protein over the last 10 or so years of life (Libby et al. 1964; Robins and New 1997; Stenhouse and Baxter 1979). Of particular interest here is the ability of stable carbon isotopes ($\delta^{13}C$, reported per mil (‰), and representing the ratio of ^{13}C to ^{12}C in a sample relative to a standard: VPDB) to distinguish between marine and terrestrial sources of dietary protein (Chisholm 1986; Chisholm et al. 1982; Schoeninger et al. 1983; Tauber 1981; Walker and DeNiro 1986). Individuals consuming an entirely marine protein diet will in most cases have bone collagen $\delta^{13}C$ values of about −12‰, while those consuming entirely terrestrial protein (from C_3 plants and the animals that feed on them) will typically have values of about −20 to −21‰. The situation can be complicated by the consumption of C_4 plants (mainly subtropical grasses such as maize and millet), since such plants show elevated $\delta^{13}C$ values comparable to those associated with marine organisms (Bender 1971). However, there are no C_4 plants native to temperate northwest Europe, so this problem can be safely ignored in the present context.

The other major element of use in isotopic palaeodietary studies is nitrogen (DeNiro and Epstein 1981). The stable nitrogen value ($\delta^{15}N$, representing the ratio of ^{15}N to ^{14}N in a sample relative to a standard: AIR) is an indicator of trophic level, as consumer $\delta^{15}N$ values are 2–4‰ higher than the values of the foods consumed (Schoeninger and DeNiro 1984). Nitrogen is only found in protein, so human $\delta^{15}N$ values must reflect dietary protein sources. By measuring the $\delta^{15}N$ values of contemporary fauna and comparing them with the human population of interest, it is possible to place the humans within that ecosystem as regards their behavior as carnivores, herbivores, or omnivores. However, marine food chains tend to be far longer than their terrestrial counterparts (Fry 1988; Minagawa and Wada 1984; Schoeninger and DeNiro 1984; Richards and Hedges 1999a), so in a case with mixed marine/terrestrial sources of protein interpretation becomes less straightforward, and will depend entirely on the extremity of the observed values. For example, if the $\delta^{13}C$ value indicates that nearly all protein was derived from marine sources, then the $\delta^{15}N$ value would reflect mainly the trophic level of the marine organisms being consumed. In the case of a more balanced contribution of marine and terrestrial foods, it may be unclear whether the $\delta^{15}N$ value indicates a combination of, for example, low trophic level terrestrial foods (i.e., plants) and high trophic level marine foods (e.g., marine mammals), or middle trophic level foods from both sources. In such cases additional lines of evidence can be brought to bear (e.g., the faunal and floral remains recovered from archaeological sites).

It is finally important to reemphasise that stable isotope analysis of bone collagen reflects only the protein component of the diet (Ambrose and Norr 1993; Kreuger and

Sullivan 1984). Many plant foods are low in protein, particularly when in an unprocessed state, so they will have minimal impact on stable isotope measurements made on bone collagen.[2] While this does limit the dietary inferences that can be made, it nevertheless seems to be the case that hunter–gatherer diets, particularly those in mid- and high latitudes, and even more so in coastal situations, can be characterized as high-protein diets (Ember 1978; Lee 1968). Furthermore, not all plant foods are low in protein: for example, nuts are relatively rich sources of protein, as are processed cereals (although lacking essential amino acids), and would be expected to make an impact on collagen isotope values were they being consumed in quantity. Hazelnuts are ubiquitous on European Mesolithic sites (Zvelebil 1994) and were encountered at both Téviec and Hoëdic.

Human bone samples were obtained from a total of 25 individuals (14 from Téviec and 11 from Hoëdic) for the purposes of AMS dating and stable isotope analysis (Table 2). Of this group, samples from 14 individuals—8 from Téviec and 6 from Hoëdic—were chosen for accelerator dating at the Oxford facility. A preliminary report on the dates has already appeared (Schulting 1999). These individuals were selected first with the intention of obtaining good spatial coverage of both sites, and second in the hopes of being able to demonstrate a chronological relationship supporting the clear stratigraphical evidence for some individuals in multiple graves being interred earlier than others. Bone collagen was extracted for isotopic analysis following standard methods (Richards and Hedges 1999a) and the isotope measurements were made at the Research Laboratory for Archaeology and the History of Art, University of Oxford. To briefly summarize the extraction and measurement protocols, approximately 300 mg of whole bone were demineralized in 0.5 M HCl at 5°C for up to 5 days. The insoluble fraction was then gelatinized in a pH 3 HCl solution at 70°C for 24 h. The resulting solution was filtered and then lyopholized. Isotope measurements were made on a Europa continuous-flow isotope ratio monitoring mass spectrometer. Sample integrity was assessed through absolute collagen yields and C:N ratios, which all fell within an acceptable range (DeNiro 1985). The precision of the stable carbon measurements presented here is ± 0.2‰, while that of stable nitrogen is ± 0.4‰.

[2]The mineral component of bone, "bioapatite", does reflect whole the diet signal but is more susceptible to problems of diagenesis, and is not addressed here, although future attempts are anticipated.

DATING

A Note on Calibration of the AMS Dates

Calibration of the dates is complicated by the incorporation of significant amounts of marine protein in the diets of the inhabitants of both sites (cf. Molto et al. 1997). Stable carbon isotope values (see below) indicate that a majority of the protein in the diet of individuals from Hoëdic was marine-derived, while at Téviec it seems that somewhat less marine food was consumed. Carbon from the ocean surface is a mixture of old deep water and atmospheric carbon, leading to a "global" (Southern Hemisphere values differ slightly) ocean surface apparent ^{14}C age of about 400 years—the so-called marine reservoir effect (Stuiver et al. 1986; Stuiver and Braziunas 1993). Thus marine organisms, dependent on carbon from the ocean, will give dates that are on average 400 radiocarbon years too old.[3] When humans acquire a significant amount of their protein from

[3]The best available estimate of the shift in reservoir values, ΔR, in 19th- and early 20th-century French waters is close to 0 (the average apparent age of six marine shell samples for different sites around the coast of France is 398 years (Delibrias 1985; Stuiver et al. 1986)), but the high standard deviation (± 125 years) emphasizes the need for correction on a site-specific basis. Efforts directed toward this are underway.

TABLE 2
Summary of Stable Isotope Results and AMS Dates on Human Bone from Téviec and Hoëdic

Site	Burial no.	Age	Sex	Lab no.	Date B.P.	±	% marine	Date cal B.C. (95% Cl)		Stable isotope values (‰)			C:N	Collagen yield (%)
										ionδ^{13}C	δ^{13}C	δ^{15}N		
Téviec	B (2)	Young adult	F?	OxA-6662	5680	50	44	4450	4250	−17.0			3.1	—
Téviec	D1 (1)	Mid-adult	F				60				−15.6	9.4	3.1	8.99
Téviec	E1 (11)	Mid-adult	M				60				−15.6	10.9	3.2	5.06
Téviec	E2 (12)	Child, 2.5 yr	I				71				−14.7	12.9	3.0	12.42
Téviec	H1 (14)	Young adult	F	OxA-6701	6000	60	49	4710	4500	−16.0	−16.6	6.8	2.9	5.11
Téviec	H2 (17)	Child, 3.5 yr	I				76				−14.1	15.3	3.1	15.56
Téviec	H3 (15)	Young adult	F	OxA-6702	6530	60	49	5360	5080	−15.2	−16.6	11.7	3.2	6.46
Téviec	K1 (8)	Mid-adult	M	OxA-6663	6440	55	60	5290	5030	−15.6			3.2	—
Téviec	K2 (7)	Young / mid-adult	M				71				−14.6	10.8	3.0	4.97
Téviec	K3 (9)	Young / mid-adult	F				67				−14.9	12.8	3.2	3.77
Téviec	K4 (10)	Adol., 14–16	F	OxA-6664	6510	50	56	5640	5090	−16.0			3.4	—
Téviec	K6 (16)	Young adult	M	OxA-6703	6500	65	63	5300	5000	−14.1	−15.4	13.4	3.4	6.46
Téviec	L (20)	Infant, 1–2 mo.	I	OxA-6704	6515	65	71	5310	5020	−14.3	−14.6	15.2	2.9	12.86
Téviec	M (13)	Young adult	M	OxA-6665	6740	60	64	5540	5330	−15.2			2.9	—
Hoëdic	A (12)	Infant	I	OxA-6708	7165	60	78	5830	5630	−13.3	−14.0	14.4	3.3	18.69
Hoëdic	B (1)	Young / mid-adult	F	OxA-6705	5080	55	68	3700	3390	−14.2	−14.9	12.3	3.5	3.09
Hoëdic	C1 (2)	Young adult	M	OxA-6706	6280	60	78	4970	4700	−13.1	−14.0	14.2	3.2	8.60
Hoëdic	C2 (3)	Infant	I				73				−14.5	13.8	3.3	5.90
Hoëdic	D (4)	Old adult	F				82				−13.6	14.2	3.2	4.85
Hoëdic	F1 (5)	Old adult	M	OxA-6709	6645	60	81	5380	5090	−12.9	−13.7	13.9	3.1	7.56
Hoëdic	F2 (6)	Mid-adult	M				87				−13.2	12.4	3.5	6.86
Hoëdic	H (8)	Young adult	F`	OxA-6707	6080	60	73	4770	4500	−13.7	−14.4	12.6	3.1	7.31
Hoëdic	J1 (7)	Young / mid-adult	F				50				−16.5	7.1	3.2	5.18
Hoëdic	K (9)	Young adult	M	OxA-6710	5755	55	74	4400	4160	−13.6	−14.3	13.3	3.1	6.35
Hoëdic	L (10)	Mid-adult	F				79				−13.9	11.0	3.1	9.68

Note. Ion exchange δ^{13}C values are those associated with the dating process and are taken to be less accurate than those obtained specifically for dietary analysis (nevertheless, the two sets of values are highly correlated, $r^2 = 0.91$. Calibrated with CALIB 4.2 mixed atmospheric / marine curve (Stuiver et al. 1998) using ion exchange δ^{13}C values; rounded to nearest decade. Here, "% marine" is calculated using assumed marine and terrestrial endpoints of −12 and −21‰, respectively; the reported % marine values should be understood as representing the midpoint of a range of ±10%. Palaeodietary values are used preferentially over ion-exchange values where possible. The δ^{13}C values are expressed relative to standard VPDB; δ^{15}N values are expressed relative to standard AIR.

the ocean, their bone collagen will be subject to the same effect, proportional to the amount of marine foods consumed. Since this is estimated by $\delta^{13}C$ values, the degree to which the marine reservoir effect needs to be applied can be approximated for each sample. For example, a date on an individual acquiring roughly half of their protein from marine foods ($\delta^{13}C \sim -16‰$) would be subject to half of the marine reservoir effect, i.e., would be 200 radiocarbon years too old. The endpoints are here defined as −21‰ for a entirely terrestrial diet, and −12‰ for an entirely marine diet. The calibrated values, taking into account the marine reservoir effect and based on the most recent marine curve (Stuiver et al. 1998), are presented in Table 2. This should be understood as a preliminary effort at calibration, and further work is anticipated. The error associated with estimating the amount of marine-derived protein in the diet furthermore means that the standard errors associated with the dates should probably be increased by at least ±10 years. Because of these complications, we will continue in subsequent discussion to refer to dates as both uncalibrated, uncorrected B.P., and as calibrated, reservoir-corrected B.C.

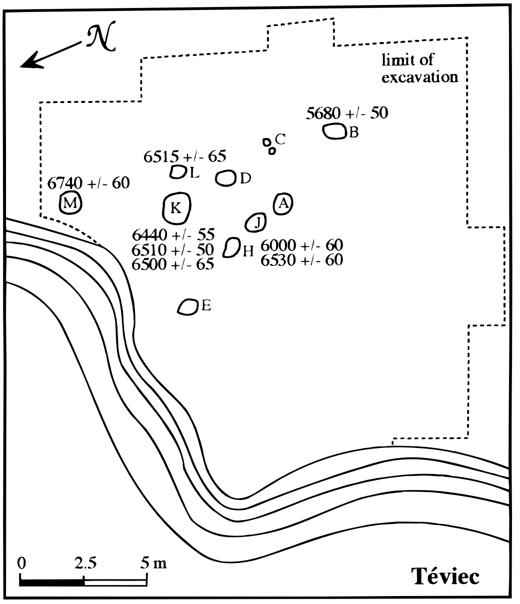

FIG. 4. Site-plan of Téviec showing the locations of AMS dated skeletons.

The Dates from Téviec

The dates from Téviec cluster reasonably well, suggesting a main period of use of the site for burial at around 6500 B.P. (5200 cal B.C. with reservoir correction) (Fig. 4). The reported position of graves with midden above and below (Péquart et al. 1937) indicates that the occupation of the site may have been longer than attested by the dates. This is probably best viewed as a shifting use of different parts of the midden for burial and occupation, the latter perhaps not year-round, resulting in a spatially variable interdigitation of midden and graves.

Three samples were selected from the six individuals in Grave K, the largest at either site, since according to the excavators a sequence of three distinct events could be discerned (Péquart et al. 1937). Burial K-6 lay at the bottom of the grave in an extended position. Two flexed individuals lay above this (K-4, K-5), in turn surmounted by the final three interments (K-1, K-2, and K-3). The lapse of a period of time sufficient for the disappearance of most or all of the soft tissue of the two middle interments is implied by the poor articulation of the skeletons, which gave the appearance of having been jostled or pushed to one side during the addition of the final two interments. Samples from the bottom individual (K-6), one of the middle two (K-4), and one of the top three (K-1) were chosen to determine whether a significant period of time could be detected between these depositional events. The results, ranging from 6510 to 6440 B.P. (5315–4970 cal B.C.), are statistically indistinguishable within the resolution of the technique.

A similar logic was applied in sampling two of the three individuals in Grave H at Téviec. Again, the excavators detected a sequence, with some individuals having the appearance of having been disturbed during subsequent interments. The most (H-3) and the least (H-1) articulated individuals were selected for sampling. In marked contrast to Grave K, a substantial period of time appears to have passed between at least these two interments (OxA-6702, 6530 ± 60 B.P., 5315–5065 cal B.C., and OxA-6701, 6000 ± 60 B.P., 4780–4505 cal B.C., respectively). The difference is on the order of 500 years, and no amount of adjusting for calibration or the amount of marine protein in the diet (which is very similar in these two individuals in any case) will significantly lessen this gap. Nor is there any good reason to discount the dates as invalid: collagen yield was adequate, and C:N ratios and stable isotope values are within the expected range. Even more surprisingly, it was the more disturbed individual that turned out to be the later interment. However, a further examination of the original report and the accompanying photographs (Péquart et al. 1937: Fig. 19) seemed to show that, unlike Grave K, the argument for the order of burial in Grave H rested not so much on firm stratigraphic evidence as on the degree of articulation of the skeletons. It is possible, then, that the more recent individual was interred in an already disarticulated state, i.e., a secondary burial. Yet the presence of many small skeletal elements does not fit comfortably with this explanation. Alternatively, it is possible, given that the grave (measuring only 0.90 by 0.85 m) contained the remains of three individuals in various states of articulation, and the length of time since the excavation (with attendant chances for bones being misplaced, etc.), that the elements dated (ulnae) actually belong to the opposite individuals. The excavators noted the difficulties involved in disentangling the individuals in this grave, although it should be stated that they nevertheless were confident in the order of interment (Péquart and Péquart 1929:377). Thus, it may be that the older date is in fact associated with the less articulated individual, and the newer date with the more articulated individual, as originally anticipated. In either case, the gap itself remains. A final possibility is that at some point in the postexcavation history of the material, elements from different graves were actually switched. Unfortunately, the only way to resolve this question may be to obtain two further AMS dates on samples taken from the crania, which can be securely identified based on published photographs and anthropological descriptions. Given the length of time between what were supposed to reflect the first and last interments in the grave, it would also be interesting to see where the third individual (H-2) falls.

The Dates from Hoëdic

The dates from Hoëdic present a much wider spread than those of Téviec. Most of this, however, can be attributed to two outlying individuals—the single occupants of Graves A and B. Both differ from the remaining graves at the site in a number of respects. The earliest dated grave at either site, Grave A (OxA-6708, 7165 ± 60 B.P., 5780–5570 cal B.C.), consisted of only the cranium of a neonate or young infant in a small pit—although it is also possible that the small and fragmentary postcranial bones had decomposed or were missed in the excavation. The grave is separated from the main group of burials by some 10 m (Fig. 5). At the opposite extreme, the most recent dated grave at either site, Grave B (OxA-6705, 5080 ± 55 B.P., 3690–3385 cal B.C.), held the partial remains of an adult female: missing were most of the bones of the hands, feet, and other elements, nor were the elements that were present in articulation, suggesting either severe disturbance or a secondary burial. Grave offerings were limited to a boar mandible. Finally, Grave B was also spatially isolated from the main cluster of graves, again by

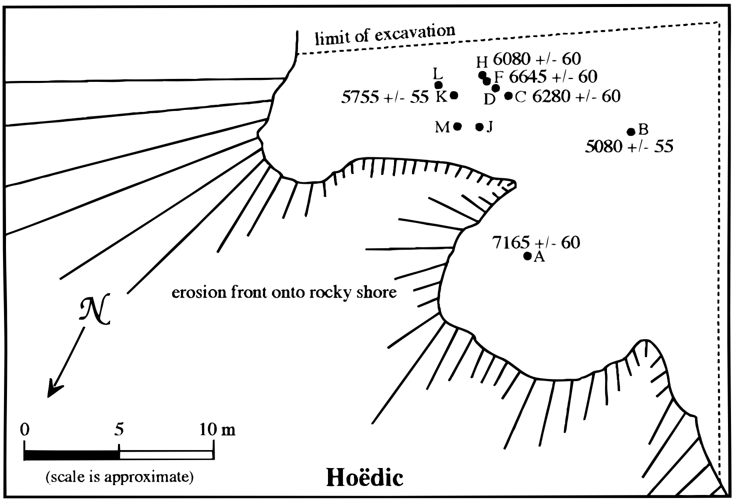

FIG. 5. Site–plan of Hoëdic showing the locations of AMS dated skeletons.

about 10 m, but in a different direction than Grave A. These three observations led the excavators to propose that the individual of Grave B represented an outsider to the community, "une femme étrangère à la colonie hoëdicaise" (Péquart and Péquart 1954:32). The very recent date indicates that this burial is also an outsider in terms of the main period of use of the site. It is worth emphasizing that by ca. 5000 B.P. (3690–3385 cal B.C.) the landscape would have had a very different appearance than it did one or two millennia earlier: it was during this time that rising sea levels separated Hoëdic from the mainland. Furthermore, as discussed below, this period falls firmly within the Breton middle Neolithic.

According to the excavators (Péquart and Péquart 1954:41–42), Graves H and F at Hoëdic shared a wall of their simple stone-built constructions; in addition, it was suggested that Grave H must be more recent, since its wall overlay a section of the stone paving of Grave F. Individuals from both graves were therefore selected for sampling, again with surprising results. The single burial in Grave H (OxA-6707, 6080 ± 60 B.P., 4765–4490 cal B.C.) appears to post-date at least one of the two individuals of Grave F (OxA-6709, 6645 ± 60 B.P., 5330–5075 cal B.C.) by some 500 years. This immediately recalls the same interval in time between two of the three interments in Grave H at Téviec, although at Hoëdic we are dealing with separate graves. Similar considerations as noted above apply in its interpretation.

The Two Sites Compared

Discounting the outliers from Hoëdic, the two sites can be seen to be largely contemporaneous. This remains the case even when the dates are calibrated and corrected for the marine reservoir effect (Fig. 6), which, as noted below, does differ slightly between the sites as a result of the apparently greater input of marine-derived protein in the bone collagen of individuals from Hoëdic. The spread of dates at both sites, but especially at Hoëdic, is more pronounced than might have been expected given the close spatial association of most of the graves. Nevertheless, the clustering of the majority of dates and the fact that many graves present relatively substantial stone constructions support the identification of Téviec and Hoëdic as "cemeteries"

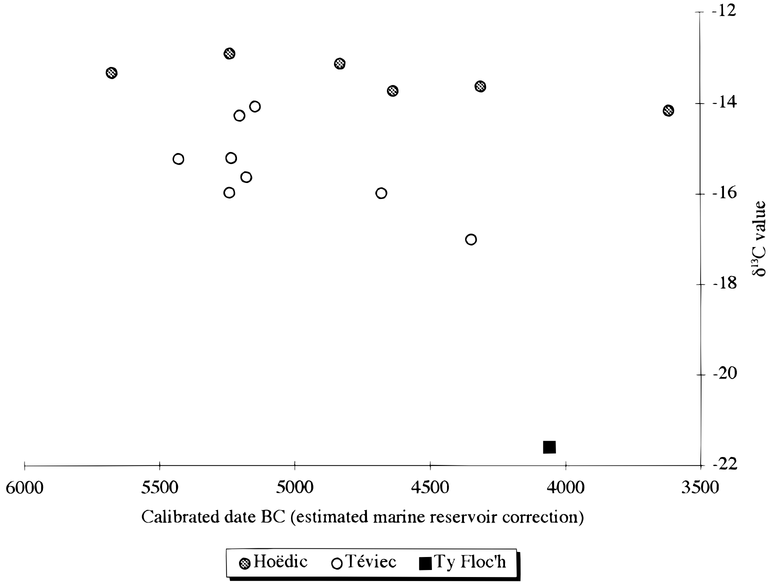

FIG. 6. Human bone collagen $\delta^{13}C$ values plotted against associated calibrated date BC for Téviec, Hoëdic, and the Neolithic passage grave of Ty Floc'h (Hedges et al. 1997). Note that $\delta^{13}C$ values associated with the AMS dating process vary slightly but systematically (ca. +0.8‰) from those determined specifically for palaeodietary analysis. Values associated with the dating process are used for the marine correction under the assumption that the carbon is behaving in similar ways for both ^{13}C and ^{14}C during the measurement process.

(if small ones) in the sense that they served as a recognized place for the interment of the dead and associated activities over a number of generations (Schulting 1996b). The apparent reuse of Grave H at Téviec after some five centuries and the incorporation of a wall of Grave F into Grave H after a similar length of time emphasize this point quite dramatically. Yet it is admittedly somewhat difficult to come to terms with the time spans involved, particularly given the small number of burials at each site. If the dates can be accepted, then there must have been many generations when no burials were made at either site (unless they have been lost through erosion)—why then were they returned to at these particular times? The related questions of whether the use of the sites for other functions preceded, coincided with, or was subsequent to their use as burial places, and what these other functions were, are issues that may not be answerable with the available data on the excavations.

Regardless of their specific interpretation, the AMS dates offer support for the successive nature of interments in the graves at both sites, as was originally recognized by the excavators (Péquart et al. 1937; Péquart and Péquart 1929, 1934, 1954). The opening of tombs for successive interment and the movement and manipulation of human remains may be part of a pattern that seems to apply quite widely in the Mesolithic and succeeding Neolithic of western Europe, and indeed may belong to a long-lasting tradition going back into the Palaeolithic, as argued recently by Cauwe (1996, in press). A single Mesolithic grave fortuitously discovered recently in Normandy also seems to display successive interment (Billard et al. 1999). Interestingly, another newly discovered Mesolithic cemetery, that of La Vergne in the interior of Charente-Maritime, does not appear to show successive interments but rather multiple interments made simultaneously within the grave (Courtaud and Duday 1995; Duday and Courtaud in press). This may be a factor of the small number (four) of graves found at the site thus far.

Finally, it is worth noting that there is some sense of spatial patterning in the dates: at both Téviec and Hoëdic the oldest graves are nearest to the eroding shoreline (Figs. 4 and 5). This strongly supports the inference made by the excavators that the sites were once considerably larger, and additional burials may have been present (Péquart et al. 1937; Péquart and Péquart 1954; see also Schulting 1996a). In the opposite direction, the late date for Grave B (OxA-6662, 5680 ± 50 B.P., 4455–4255 cal B.C.) at Téviec provides some support for the Péquarts' supposition that the site may have once extended farther inland where the bedrock was closer to the surface, preventing soil accumulation and/or increasing the chances of subsequent erosion. Likewise, Hoëdic's most recent grave (Grave B, discussed above) is also found furthest away from the shore.

A Note on the Contemporary Coastline

While Téviec and Hoëdic today are on small islands, lower sea levels at the time of their occupation implies that both were attached to larger land masses. Eustatic sea levels off the Atlantic coast of western France rose very rapidly from 10,000 to 7500 B.P., followed by a series of oscillations and later transgressions (Morzadec-Kerfourn 1985; Prigent et al. 1983; Ters 1973), so the exact placement of the sites in relation to the contemporary coastline depends on when they were in use. Now that at least the use of the sites for burial can be well situated chronologically, this question can be addressed more precisely (refer to Fig. 1). Nevertheless, the situation remains complex, with the Bay of Quiberon comprising a palimpsest of rocky ridges, sand, and silts, the latter two of which are of course subject to movement over time (P.-R. Giot, personal communication 1999). Téviec is the simpler of the two cases, given that the available dates cluster much more tightly. At about 6500 B.P. sea levels would have been some 10 m lower, placing the site approximately one kilometer from the coast. With evidence for use spanning two millennia, Hoëdic is more complex. At around 7000 B.P., the sea would have been roughly 15 m lower than at present, and Hoëdic would have been part of a larger group of what are now a series of islands, possibly attached to the mainland; thus the site itself could have been up to two kilometers from the coast at this time. By 5000 B.P., Hoëdic, while slightly larger, would appear much as it does today. Interestingly, there is no indication from the stable isotope evidence, discussed below, that marine resources were less important in the earlier period, when the site would have been further from the sea.

The earliest date from either site, that of 7165 ± 60 B.P. (OxA-6708) from Hoëdic, is broadly comparable to two other early dates from the Breton shell middens of Point St-Gildas (Loire-Atlantique) (GIF-3531, 7520 ± 140 B.P. (Delibrias and Guillier 1988)) and Beg-an-Dorchenn (Finistègre) (GIF-6858, 7280 ± 80 B.P. (Kayser 1991)). The latter two dates are on marine shell, so they are also subject to a marine reservoir correction; they do, however, remain earlier, since the early date from Hoëdic must also be corrected. But taken together the three dates would seem to provide some rough idea of the earliest surviving shell midden sites in the region—these sites were not situated directly on the coast given the lower sea levels of the time, and both contemporary Atlantic period and earlier coastal sites must now be inundated (cf. Prigent et al. 1983).

MESOLITHIC DIET AT TÉVIEC AND HOËDIC

The stable carbon isotope results from Téviec and Hoëdic present a consistent set of data that make it clear that a substantial part of the protein component of the diet was derived from the sea (Tables 2 and 3, Fig. 7). This is particularly the case with individuals at Hoëdic, which seem to show on average a significantly greater reliance on marine-derived protein. While the average $\delta^{13}C$ value of -14.3 ± 0.9‰ for Hoëdic suggests that approximately 70 to 80% of the protein in the diet of those individuals measured was from seafoods, the average of -15.3 ± 0.9‰ from Téviec is indicative of a more balanced economy incorporating both marine and terrestrial protein sources in more nearly equal proportions. While the interpretation of stable carbon isotope results can be confounded by environmental factors in some situations, such as those found in the Baltic Sea area (e.g., Lidén and Nelson 1994), isotopic differences of the order observed between Téviec and Hoëdic, within a small region on a relatively open coast, cannot be accounted for by any other means than a real dietary difference. Furthermore, the $\delta^{13}C$ results are supported by a corresponding trend in the $\delta^{15}N$ results of 12.6 ± 2.1‰ for Hoëdic compared to 11.9 ± 2.6‰ for Téviec, although in this case the difference is not statistically significant. The larger standard errors seen in $\delta^{15}N$ suggest that there is greater variability in the diet than is apparent in the stable carbon results.

TABLE 3
Average $\delta^{13}C$ and $\delta^{15}N$ values for Age/Sex Groups

	Average				
Age / sex	$\delta^{13}C$	*SD*	$\delta^{15}N$	*SD*	*n*
Téviec					
Adult male	−15.2	0.5	11.7	1.5	3
Adult female	−15.9	0.8	10.2	2.7	4
Subadult	−14.2	0.3	14.1	0.5	3
Overall	−15.3	0.9	11.9	2.6	10
Hoëdic					
Adult male	−13.8	0.5	13.4	0.8	4
Adult female	−14.6	1.1	11.4	2.7	5
Subadult	−14.5	0.3	14.5	1.4	2
Overall	−14.3	0.9	12.6	2.1	11

The apparent greater use of marine resources at Hoëdic may at first glance be seen as somewhat surprising, given that the site was further than Téviec from the coast throughout much of its main period of use. But the difference in the distance from the sea between the sites is not great, being on the order of a kilometer or so. And, as noted above, the locations of the sites relative to the sea was a dynamic one, changing over time. A potentially more important distinction lies in Hoëdic's more isolated position, whether attached to the mainland by a peninsula or as part of a larger island complex (Fig. 1). This may have encouraged a more maritime subsistence orientation here, whereas the location of Téviec gave easier access to a larger terrestrial hinterland. It is unfortunate that faunal remains were not recovered / reported in greater detail so that this idea could be explored further.

While we do argue here that the results from Téviec show greater use of terrestrial resources, a partly alternative and partly complementary account may be formulated, in which the inhabitants of Téviec made greater use of inshore marine species, which under certain conditions—especially estuarine situations (Haines and Montague 1979; Owens and Law 1989; Peterson et al. 1985; Thornton and McManus 1994)—can display isotopic values intermediate between more typical marine and terrestrial values. This is a difficult issue to address in the absence of a series of isotopic measurements on relevant contemporary fauna. However, the local topography suggests that estuarine conditions are unlikely to have been significant in the 10 km catchments of either site (see Fig. 1). In either case, the main point is that the difference in diet indicates that separate and distinct human groups made use of these sites,

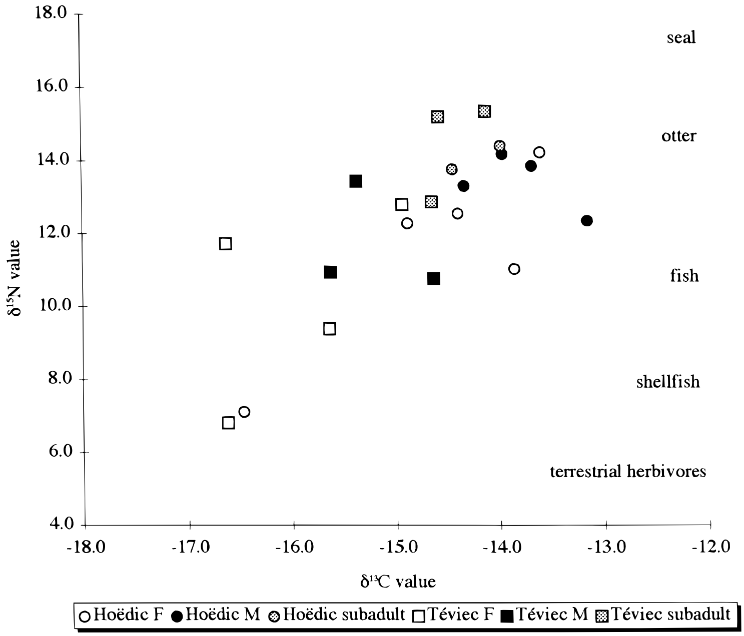

FIG. 7. Human bone collagen δ^{13}C and δ^{15}N values from Téviec and Hoëdic. Also indicated are approximate δ^{15}N values of a range of animals at different trophic levels from roughly contemporary sites across Atlantic Europe (data compiled from Richards and Mellars 1998, Richards and Hedges 1999, Schulting 1998b). Consumer δ^{15}N values will be approximately 3‰ higher than dietary source.

since the average isotopic values should be indistinguishable if they reflected a single, highly mobile "population" (we use this term loosely here, and not in its genetic sense; the groups using Téviec and Hoëdic were no doubt part of a single larger mating network—see discussion below). This provides an added level of detail to the larger-scale regional differences in microlith styles noted by Kayser (1991, 1992) and Marchand (1999).

In addition to broadly confirming the use of marine-derived protein in the diet of the inhabitants of Téviec and Hoëdic, the δ^{15}N results provide an indication of the kinds of marine foods that were being exploited. As noted earlier, each increase in trophic level involves a δ^{15}N increase of approximately 3‰; thus the organisms consumed by humans would be 3‰ lower than the humans themselves. By comparison with the δ^{15}N values of various marine species (Fig. 7), it can be suggested that fish were the main source of protein in those individuals with high δ^{13}C values (i.e., those individuals acquiring most of their protein from the sea). Reliance on shellfish or marine mammals such as seals would be expected to result in lower and higher δ^{15}N values, respectively. This finding is similar to those from other coastal Mesolithic populations in Portugal, Denmark, and Scotland (Richards and Hedges 1999a).

With regard to any temporal trends, the isotopic data are ambiguous (Fig. 6). There are two conflicting expectations: one is that there might be an increase in the use of marine resources through time at the two sites, if for no other reason than rising sea-levels and increasing proximity to the coast. Increasingly effective maritime technology and the depletion of large terrestrial game could be other relevant factors. Counteracting this, the appearance and subsequent adoption of elements of a "Neolithic" economy in the area might be expected to result in a decreasing emphasis on marine resources. While there is some indication that the latest individuals in the sequence show slightly less use of marine protein, the pattern becomes confused when age and sex are taken into account (see discussion below). Nevertheless, the trend toward less use of marine resources could conceivably reflect the incorporation of new terrestrial-based foods that may have made an appearance along the coast of Morbihan as early as 6000 B.P. (Tresset and Vigne in press; Visset et al. 1996). Overall, however, it seems that even after domesticated resources became available, the groups using Téviec and Hoëdic continued a subsistence pattern apparently established by at least 7000 B.P. (ca. 5800 cal B.C.).

Stable Isotopes in Relation to Age, Sex and Status

Interesting patterns emerge in the isotopic data with regards to age and sex. First, the small number of infants and young children available for analysis (see Table 1) were found to differ significantly in both their $\delta^{13}C$ and their $\delta^{15}N$ values. The stable carbon data will be discussed further below, since their explanation involves an interaction between age and sex. Infants and young children at both sites show $\delta^{15}N$ values elevated above the site average (Tables 3 and 4; Fig. 8). The most likely explanation for this involves the nursing effect; it is also possible that the difference relates partly to the measurement of different elements of the skeleton (see below). Isotopically, breast-feeding infants are expected to show values approximately 3‰ higher than their mothers, since they are in effect feeding off of them and so operate at a higher trophic level (Katzenberg et al. 1993; Schurr 1997). And indeed the observed values fall very close to this expectation. A fall-off would be seen only sometime after weaning had occurred, since the child's bone would retain collagen laid down during breast feeding as well as new collagen (with lower $\delta^{15}N$ values) incorporated into the growing bone after weaning. Thus the fact that a child (H-17) of some 3 to 4 years of age still exhibits an elevated $\delta^{15}N$ value is not unexpected, and does not necessarily imply that it had not been weaned. Unfortunately, there are no older children in the sample to permit a further investigation of the issue.

An apparent relationship is also discernible between $\delta^{13}C$ values and sex. At both sites, females show a trend toward more negative values, that is, *less* consumption of marine-derived protein. Given the small sample sizes involved, this difference does not reach statistical significance (at the .05 probability level) for either site. The difference between males and females is statistically significance ($p = .049$) when the results from both sites are combined (after standardizing the values to control for the different averages from the two sites, as noted above) (Tables 3 and 4). Stable nitrogen values follow the same pattern, although not attaining statistical significance. It is unfortunate that data for two females and two males from Téviec cannot be used because only ion-exchange values associated with the AMS dating process are available,

TABLE 4
***t*-Test for $\delta^{13}C$ and $\delta^{15}N$ *Z*-Scores Comparing Age/Sex Groups**

Groups compared	$\delta^{13}C$		$\delta^{15}N$		n
	t	*p*	*t*	*p*	M/F
Male–Female	2.157	0.049	1.770	0.099	7/9
Adult–Subadult	−2.061	0.053	−3.605	0.002	16/5
Female–Subadult	−2.631	0.022	−3.529	0.004	9/5
Male–Subadult	−0.739	0.477	−2.509	0.031	7/5

Note. Tests are all two-tailed and take unequal variance into account.

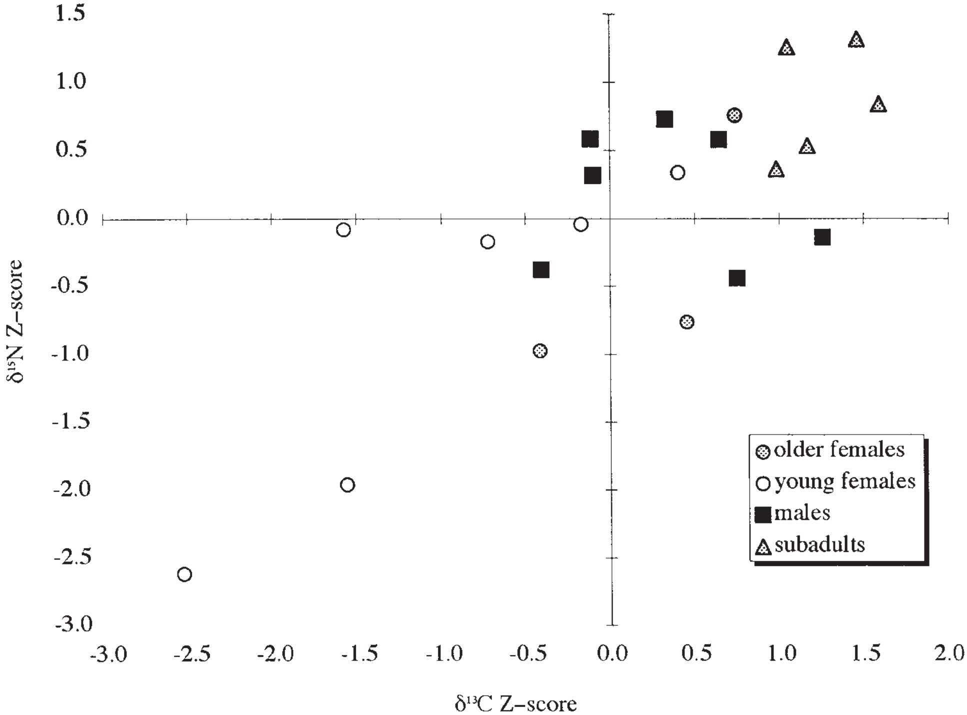

FIG. 8. Plot of standardized $\delta^{13}C$ and $\delta^{15}N$ values for adults and subadults from Téviec and Hoëdic.

and these are not directly comparable to the values obtained specifically for palaeodietary analysis. However, it is worth noting that the stable carbon results show the same trend (and this is even more apparent when the ion-exchange values are corrected by the use of least-squares regression [r^2 = .91] to fall in line with the palaeodietary values; to avoid complicating the issue, we have not employed these corrected figures in the following analysis and discussion).

Finally, it may be noted that no relationship was found between the stable isotope results and socioeconomic status as inferred from the number and kinds of grave inclusions (Schulting 1996a). This is not necessarily unexpected, since in small-scale societies such as those of the European Mesolithic, any differential access with regards to food that did exist would most likely involve special animals or plants, or certain desirable parts of more ordinary animals or plants rather than the broad food categories (marine : terrestrial, plant : animal) that are amenable to isotopic discrimination. Fats in particular, which do not contribute to the makeup of bone collagen (Ambrose and Norr 1993; Kreuger and Sullivan 1984), would probably be valued in a high-protein diet such as that indicated for the inhabitants of Téviec and Hoëdic (cf. Speth and Spielmann 1983). Indeed, the abundance of fat on domestic animals may have been one of the attractions leading to their adoption.

Explaining the Difference: Food Taboo or Marriage Pattern?

The relationship that we would like to explore further is that involving the differences in diet between the sexes. Before continuing, however, it is necessary to address two points. First, studies have found no physiological differences between the sexes in this respect; men and women, when eating the same foods, exhibit the same stable isotope values (DeNiro and Schoeninger 1983; Hobson and Schwarcz 1986; Lovell et al. 1986). Second, it should be emphasized that, although the same element could not be sampled for each skeleton (the ideal case), there appears to be no consistent relationship between ele-ment and isotopic value,[4] either in the data presented here or in the general literature (Bonsall et al. 1997; DeNiro and Schoeninger 1983). Such a difference might come into play in two situations. The first involves infants and young children, where bone is forming rapidly but at different rates throughout the skeleton. Changes in diet during this period (provided again that they are between isotopically distinct food classes) can be expected to yield different isotopic values for different parts of the skeleton. The second situation is when an adult changes his or her diet abruptly, as might accompany, for example, a move from an inland location to the coast. Bone in the skeleton turns over at different rates, so that any sudden shift in diet could be detected sooner in some elements than in others; in general, denser, more compact bone (e.g., femur) is thought to turn over at a slower rate than less dense cancellous bone (e.g., rib) (Sealy et al. 1995). Regardless, the difference in either case for a complete turnover of bone is on the order of years. One of the advantages (or disadvantages, depending on your view) of stable isotope analysis is that it presents an averaged, relatively long-term view of an individual's diet, and it is not subject to daily or seasonal variation. Thus shifts in an individual's diet, even if they are very sudden, will only gradually appear in their bone collagen.

After ruling out physiological explanations, we are left with two possibilities. One involves culturally imposed food restrictions—"taboos"—for either men or women. The observed difference, while significant, is not that great. Strictures against a class of animals, or even one particular species, if it formed around 10% of the protein consumed, could account for the difference. Thus, for example, it may be that women were forbidden to consume a certain recognized class of marine fish and instead ate more protein from terrestrial sources; the effect would be the same if men were forbidden to eat a category of terrestrial animal (indigenous temperate European plant foods, with the important exception of hazelnuts, do not enter into the discussion as they typically contribute little protein to the diet) and made up the balance by consuming proportionally more seafoods. Such food restrictions would not necessarily need to operate continually; those that came into effect periodically, as long as they involved proportionally more of the isotopically distinct protein source, could produce the same result (an extreme example would see all seafoods interdicted for a period of time, say, one month of the year). Certainly gender-based food restrictions are well-documented in the anthropological literature (e.g., Caplan 1994; Hugh-Jones 1978; Zvelebil 1999). One especially germane example comes from the Wamira of New Guinea, among whom women are forbidden from consuming seafoods during pregnancy and nursing (Kahn 1986, cited in Hastorf 1991). A somewhat different scenario would involve differential food acquisition and consumption activities for men and women that relate not so much to explicit restrictions as to the daily habits and unspoken rules that also govern food distribution. Men and women may gather much of their own daily food, for example. For women this might include more plant foods and such marine foods as shellfish (cf. Moss 1993). For present purposes both these types of food restrictions are treated together.

[4]The usual reason for preferentially sampling femora or other dense bone has to do with the lower susceptibility of these elements to diagenesis (e.g., Lambert et al. 1982); in the present study collagen yield and C:N ratios are used to check for collagen degradation (see Table 2).

But another possibility is that the observed difference in stable carbon isotopes results from an exogamous, patrilocal marriage pattern, with women marrying in from a greater variety of locations, including some more inland communities. This is an explanation that has been suggested for similar observations in human bone collagen $\delta^{13}C$ values elsewhere (Bonsall et al. 1997; Richards and Mellars 1998; Walker and DeNiro 1986), but to our knowledge it has never been explored in any detail. Assuming that these two alternatives are largely mutually exclusive (in reality, of course, they need not be), is there any way of choosing between them? If cultural restrictions on certain foods are implicated, it might be expected that values for the sexually indeterminate infants and children would show a bimodal distribution in values, or at the least a wider range of values than that seen in a single adult sex. This is not the case. In fact, the subadults clearly separate from the adult females and instead group with the adult males, showing an equivalent emphasis on marine protein (Fig. 8). This evidence is not conclusive, however, since it is conceivable and indeed likely that any imposed food restrictions (or difference resulting from differential access to foods) would only come into effect upon reaching “adulthood”, however that was defined by the Mesolithic inhabitants of Brittany (e.g., first menstruation for women). Children would thus not be gendered until adopting adult roles, and until then might not be subjected to food restrictions.

Is there any other means of evaluating the hypothesis? If an exogamous marriage pattern is implicated, the bone collagen of younger women should retain more of their original inland “terrestrial” isotopic signature than that of older women, whose bone collagen would have had longer to change over to reflect their new marine-oriented diet (see above discussion). To test this, females were divided into two age-groups, younger adult and older adult, the dividing point being roughly 35 years as determined by dental wear, which may exaggerate the age of the younger individuals in particular, given the usually high rates attrition associated with fisher-hunter-gatherer diets.[5] The difference in $\delta^{13}C$ values does not quite reach statistical significance at the standard .05 level (Table 5), but it is nevertheless very suggestive.[6] The slight difference in $\delta^{15}N$ values follows the expected trend, with younger women showing lower values. The results suggest that older women do show greater use of protein from marine sources; in fact they are indistinguishable from the adult male group. Younger women, by contrast, separate out more strongly from all other age / sex classes (Fig. 8), providing tentative support for their allochthonous origins. (It might be added here that the two females from Téviec for which only ion-exchange values are available further support the trend; the young adult female has the lowest value of either site, while the adolescent female has the second lowest ion-exchange value (Table 2).)

It should be emphasized at this point that the suggestion is not that all females were being recruited from inland communities but rather that females were marrying in from a variety of locations, including some more inland communities, although even these may have made some seasonal use of marine resources, whether through direct

[5]In fact there is a significant discrepancy between the ages assigned by Boule and Vallois in the original publications based largely on cranial suture closure (Péquart et al. 1937; Péquart and Péquart 1954) and the ages as determined by dental wear (Caillard in Newell et al. 1979; personal observation by R.J.S.), the former often being younger. This is the subject of ongoing research, but it can be noted here that using the original age assessments presents an even stronger distinction between younger and older women.

[6]We are using an exploratory approach rather than rigorously testing a hypothesis (in which case we might have chosen a one-sided test, which would have been significant at the .05 level); we are more concerned here with committing what in statistical jargon is called a type 2 error: failing to recognize a significant relationship.

TABLE 5
Comparison of Standardized Isotope Values for Older and Younger Adult Females (the Latter Includes Young/Mid-adult Category)

Site	Burial no.	Age	$\delta^{13}C$	$\delta^{15}N$	$\delta^{13}CZ$	$\delta^{15}NZ$
Hoëdic						
	D (4)	Old adult	−13.6	14.2	0.91	1.04
	L (10)	Middle adult	−13.9	11.0	0.69	0.16
	B (1)	Young / Mid-adult	−14.9	12.3	−0.21	0.31
	J1 (7)	Young / Mid-adult	−16.5	7.1	−1.61	−1.62
	H (8)	Young adult	−14.4	12.6	0.21	0.42
Téviec						
	D1 (1)	Middle adult	−15.6	9.4	0.39	−0.30
	K3 (9)	Young / Mid-adult	−14.9	12.8	1.24	0.99
	H1 (14)	Young adult	−16.6	6.8	−0.81	−1.27
	H3 (15)	Young adult	−16.6	11.7	−0.82	0.58
Average (older females, > c. 35 yrs) =					0.66	0.37
Average (younger females, < c. 35 yrs) =					−0.33	−0.10
$t=$					2.26	0.56
$p=$					0.06	0.60

Note. Tests are all two-tailed and take unequal variance into account.

access and / or trade. Indeed, use-rights to marine resources may have been maintained partly through marriage alliances with coastal groups. That plant sources of protein (e.g., hazelnuts are particularly rich in protein) may have played an important dietary role in some locations (accepting for the moment the exogamous female scenario) is hinted at by the low $\delta^{15}N$ values of 6.8‰ and 7.1‰ for two young adult females, although comparative values for contemporary plant foods, herbivores, and carnivores from the area would be needed to strengthen any such claim. Unfortunately, the total lack of preserved bone from inland contexts in the Breton Mesolithic does not permit a further investigation of inland diet through either faunal evidence or human bone chemistry. But the idea receives further tentative support from the higher caries rates in females (ca. 8% of posterior teeth) compared to males (ca. 3% of posterior teeth) (R. Schulting, personal observation) (although given the small sample size the difference is not statistically significant—a more detailed treatment of the caries rates is the subject of a work in preparation).

There is no artifactual evidence (in the form of grave inclusions) to indicate an inland origin, or the maintenance of inland ties, for the women. On the other hand, it is difficult to know of what such evidence might consist. The flint that dominates the lithic industry appears to derive mainly from beach pebbles, although some other materials may have an inland origin. Of course this says nothing about how such materials were acquired. Similarly, the sources of red ochre that figured prominently in the mortuary ritual (Schulting 1996a) likely derive from the interior, although to our knowledge no specific locales have been identified.

The need for coastal communities to obtain marriage partners from inland groups may be, in part, predicated by the former's circumscribed topographical position. Other things being equal, coastal communities on average have fewer neighboring groups than land-bound communities and so, especially under conditions of relatively low population density, would be obliged to join with inland groups in order to maintain viable mating networks (cf. MacDonald and Hewlett 1999; Mandryk 1993; Wobst 1974, 1976). Indeed, such a pattern should be expected in general terms, although its specific form—in the present case argued to be predominantly patrilocal, with women moving from interior to coast (and possibly in the reciprocal direction as well)—may vary from situation to situation. However, it should be added that the constrained location of coastal communities would be to some extent, and depending on the available technology, mitigated by the communication corridor offered by the sea itself, so that travel may have extended further linearly than would be feasible in a situation reliant on overland travel. The observed pattern and its suggested interpretation, then, while perhaps not surprising, should not be considered as "expected", as it seems that other solutions would have been possible. Another relevant factor might involve emic perceptions of differential social standing between more complex coastal communities and simpler inland communities, leading to hypergyny, the movement of women in marriage from lower status communities to those of higher status (cf. Zvelebil 1998). In this regard, it is interesting to note that none of the eight stable isotope values for a group of 12 individuals from the recently discovered earlier Mesolithic cemetery of La Vergne show any indication of a marine diet (Schulting and Richards, unpublished data). The site is well to the south of the Morbihan, in Charente-Maritime, and is over 40 km from the modern coast. Nevertheless contacts with the coast are shown by the presence of hundreds of marine shells of various species, pierced for use as ornamentation (Courtaud and Duday 1995; Duday and Courtaud 1998). As intimated above, perhaps the movement of women in marriage from interior to coast was predominantly one-way.

In terms of the possible distances involved in the movement of marriage partners, a recent study by MacDonald and Hewlett (1999: Fig. 3) suggests a mean mating distance of about 40 km for highly mobile foragers in relatively marginal environments, compared with a mean mating distance of some 10 km for horticulturalists with much higher population densities. It might be expected that the Mesolithic fisher–hunter–gatherers of Brittany, arguably lying toward the socioeconomically "complex" side of the hunter–gatherer continuum and living in a relatively rich environment, would fall between these points (which are in any case associated with a high range of variability). Such distances, on the order of 20–30 km, provide a reasonable first estimate and may suggest some future directions for investigations in the interior of Morbihan. Detailed comparisons between lithic assemblages at this distance with those closer to the coast could be made, for example (some work along these lines has already been carried out by Marchand (1999), but the differences noted so far occur at a broader scale). While it was not so long ago that the Mesolithic occupation of Brittany was thought to be largely restricted to the coast, more recent fieldwork in the interior has demonstrated a significant inland presence (Gouletquer 1991; Gouletquer et al. 1996; Kayser 1992). In light of the above figures, it is interesting to note the occurrence of a distinct band of sites some 20 km inland from the modern coast in the *départment* of Finistère in northwest Brittany, although this may largely reflect the presence of lithic sources (Gouletquer et al. 1996).

Thus, while neither scenario—culturally imposed food restrictions or exogamous marriage pattern—can be ruled out, the balance of the evidence appears to favor the hypothesis that in-marrying women are responsible for the observed differences in male and female stable isotope values. Further $\delta^{13}C$ analysis on teeth would help resolve this issue (the dentine component of teeth forms during childhood and changes minimally thereafter) and is planned for the future. White et al. (1998) have successfully distinguished pre-Columbian groups living in the valleys of Oaxaca and Mexico using stable oxygen isotope analysis of human bone. A similar approach could have potential in Brittany, but the lack of comparable inland bone samples is, again, a serious drawback. (This also precludes testing the hypothesis that some women from coastal communities were in turn marrying into inland communities.) Lead and strontium isotope analysis may also provide useful complementary approaches (Montgomery et al. 2000; Price et al. 1998), provided that geological sources are sufficiently isotopically distinct over the relatively short distances envisaged for the movement of people in southern Brittany.

TÉVIEC AND HOËDIC AND THE MESOLITHIC–NEOLITHIC TRANSITION

The stable isotope data and the AMS dates discussed here both have major implications for our understanding of the Mesolithic–Neolithic transition in Brittany. In terms of the wider European context, our increasing knowledge of local sequences is promoting a greater appreciation of regional variation in the process of neolithization; this, in turn, will feed back into the construction and assessment of models that attempt to explain larger-scale trends.

While the stable isotope data provide a good baseline for understanding coastal Mesolithic diet in southern Brittany, comparison of these values with those of "Neolithic" individuals (by which is meant here individuals from "Neolithic" contexts, such as long houses, long mounds, and chambered tombs) is problematic given the poor representation of human remains from this period. Three sites have yielded dates on human bone that fall within the period of interest. A human bone from a chamber of the passage grave at Beg-an-Dorchenn, Finistère, has provided an accelerator date of 5490 ± 90 B.P. (GIF-A92372) (Giot et al. 1994). Unfortunately, no associated stable carbon isotope value is available. The same problem applies to the AMS date of 5260 ± 90 B.P. (GIF-A92374) on human bone from the passage grave of Roc'h Avel, Finistère (Giot et al. 1994). A comparable AMS date of 5270 ± 80 B.P. (OxA-5974) on human bone from the passage grave of Ty Floc'h, Finistère is associated with a purely terrestrial $\delta^{13}C$ value of −21.6‰ (Hedges et al. 1997). However, this site is located some 25 km inland, and it may be that contemporary sites closer to the coast would show some use of marine resources. Finally, a human bone from the later Neolithic *allée couverte* at Beg an Dorchenn yielded a $\delta^{13}C$ value of −19.5‰ (indicating at most a very minimal input of marine foods, on the order of 5% or so); while located directly on the coast, this individual is too recent to be directly relevant to the events being discussed here (OxA-5363, 4140 ± 55 B.P. (Hedges et al. 1997)). It does serve to show, however, that mere proximity to the coast does not in itself mean that marine foods will form a significant contribution to the diet.

The timing and nature of the appearance of the earliest Neolithic in Brittany are controversial (for recent reviews, see Patton 1994; Scarre 1992). A number of early charcoal dates (ca. 5800 B.P., 4600 cal B.C.) from passage graves have recently been questioned (Boujot and Cassen 1993); related to this is a vigorous debate concerning the chronology of pottery styles and the primacy of passage graves or long mounds, seen as representing two distinct Neolithic traditions in Brittany (Boujot and Cassen 1993; Cassen 1993; Cassen and Muller 1992; Giot et al. 1998; Giot et al. 1994; Scarre 1992; Scarre et al. 1993; Sherratt 1990). Recent excavations on the monument complex of Petit Mont in Locmariaquer unequivocally show that, here at least, a long mound preceded a passage grave (Lecornec 1994). Dates of 5680 ± 50 B.P. (OxA-6662) from Téviec and 5755 ± 55 B.P. (OxA-6710) and 5080 ± 55 B.P. (OxA-6705) from Hoëdic, particularly when corrected for the marine

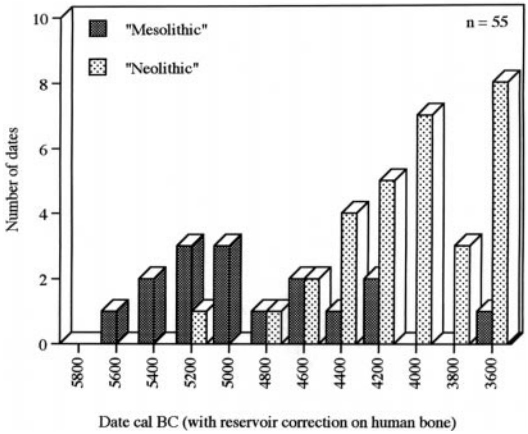

FIG. 9. Calibrated ^{14}C dates from late Mesolithic and early Neolithic contexts in Morbihan (excluding palaeoenvironmental dates); the Mesolithic dates are comprised of the AMS dates on human bone from Téviec and Hoëdic, together with one charcoal date from Hoëdic, and a date on marine shell from Beg-er-Vil (Kayser and Bernier 1988).

reservoir effect, are surprisingly late and further complicate the already convoluted sequence of events in southern Brittany during the late sixth and fifth millennia B.C.

Figure 9 sets out the chronological relationship between the late Mesolithic and the Neolithic within the *département* of Morbihan, taking into account the new dates from Téviec and Hoëdic. The number of radiocarbon dates from Neolithic contexts has increased significantly in the last few years as a result of major projects at the site complex at Locmariaquer, including the monuments of Table des Marchand, Petit Mont, and Er Grah (Cassen and L'Helgouac'h 1992; Lecornec 1987, 1994). Most striking is the dating of a pit containing the articulated remains of two domesticated cattle underlying the secondary cairn at Er Grah to the end of the sixth millennium or the beginning of the fifth millennium B.C. (Tresset and Vigne in press). In addition, recent palynological studies at Kerpenir in the Gulf of Morbihan have indicated that large-scale forest clearances associated with cereal-type pollen may have been instigated at approximately the same time, i.e., as early as 6000 B.P. (ca. 4900 B.C.) (Visset et al. 1996). This evidence clearly overlaps in time with the use of Téviec and Hoëdic, both located only some 30 km distant. The Kerpenir finding is exceptional in its early date and in the scale of the clearances, but other studies indicate an agricultural landscape underlying many early monuments in Morbihan and in Brittany more generally (Gebhardt and Marguerie 1993; Marguerie 1987, 1992). Thus, burial at these two "Mesolithic" sites continued into the period during which it seems that, in the same general area, long mounds, decorated menhirs, passage graves, and stone alignments were being erected (and in some cases destroyed, with fragments of menhirs reincorporated into passage graves) (L'Helgouac'h 1983; Lecornec 1994; Le Roux 1984; Patton 1994), domestic animals were being kept, and cereals were being grown. This presents the possibility that two distinct cultures coexisted in coastal Morbihan for a considerable length of time (as was suggested by Sherratt (1995: 255)). Alternatively, it may be that the later burials at Téviec and Hoëdic are of "Neolithic" individuals in the sense that they participated in the cycle of monument building and associated activities, but not in a fully Neolithic economy (ruled out by the stable isotope data). Thus there are a number of possible interpretations of the data:

1. The late dates are in error—there is no reason to suspect that this is the case; correction of the dates for the reservoir effect is more controversial, but three dates overlap with what has been proposed as the earliest Neolithic in the area even before any such correction.

2. The stable isotope values are in error—there is no reason to suspect the isotope values as a whole, particularly since a number of individuals were in effect measured twice, once during the dating process

and again specifically for palaeodietary analysis (Table 2).

3. Two separate and distinct "cultures" were present on the coast of Morbihan in the fifth millennium B.C., an indigenous "Mesolithic" group and a presumably, though not necessarily, intrusive "Neolithic" group.

4. The late burials represent marginalized individuals who participated in certain aspects of "Neolithic" activity but had minimal access to novel resources and were excluded from monuments upon death.

5. The earlier Neolithic economy on the coast of Morbihan was essentially unchanged from the Mesolithic, focusing largely on marine resources, with domestic resources forming a small component of day-to-day subsistence. This would contrast strongly with the situation as currently envisaged by the authors for southern Scandinavia, Britain and Ireland.

The idea that the late burials at Téviec and Hoëdic represent economically marginalized individuals, while intriguing, is difficult to assess in the absence of comparative dates and isotope values on human bone from the monuments of the area. As noted above, Grave B (5080 B.P.) from Hoëdic does appear to differ from the main group of graves at the site. Not only is it somewhat removed spatially from the main cluster of graves, but it appears to represent a secondary burial, and its grave inclusions are among the poorest at either site (consisting of only a boar mandible). But while this individual does look "marginalized," the same cannot be argued for the two other individuals with post-6000 B.P. dates (premarine reservoir correction). Grave K at Hoëdic (5755 B.P.) is in fact one of the three richest graves at that site, containing retouched flint blades, a bone "stylet," antler picks or clubs, red ochre, and abundant and varied shell ornamentation. Moreover, this is one of four graves at the site associated with deposits of red deer antlers. None of these items are out of place with the inventories of earlier graves at either site (Schulting 1996a). A similar argument applies to Grave B at Téviec (5680 B.P.); this grave again contained a variety of items—including two "stylets" and abundant shell ornamentation—that in no way stand out from earlier graves. What does distinguish this individual is its $\delta^{13}C$ value of −17.0‰, the most negative (i.e., terrestrial) value at either site. Unfortunately, this is the value associated with the AMS date which experience suggests is less reliable than measurements obtained specifically for palaeodietary analysis (insufficient bone sample remained for isotopic analysis, precluding this individual from inclusion in the dietary analysis; nevertheless it may be remarked that on the basis of skeletal morphology it was identified as "probable female"). In any case, the $\delta^{13}C$ values (ca. −14‰) from the two late individuals at Hoëdic do not show a similar trend but rather remain strongly "marine". The total absence of pottery from any of the graves at Téviec and Hoëdic is also worth emphasizing—pottery certainly forms at least a small component of the activities associated with both early passage graves and long mounds in Brittany (Boujot and Cassen 1993; Giot 1987). The impression at this point—and this is very preliminary until further isotopic results are available from individuals in "Neolithic" contexts—is that the communities represented by Téviec and Hoëdic had little or nothing to do with events on the mainland some 30 km distant. This in turn calls into question whether late Mesolithic groups in the area played any key role in contemporaneous and subsequent events in south Brittany, as has often been suggested.

An alternative explanation is that late Mesolithic communities did play an important role in the appearance of the "Neolithic" in the region, but that the Mesolithic communities themselves were already socially and economically differentiated. An incipient "elite" may have appeared by the end of the sixth millennium B.C. (Schulting 1996a); taking advantage of new opportunities offered by the appearance at this time of novel resources and esoteric knowledge in communities within their sphere of interaction, these families or lineages may have proceeded to intermarry and build alliances among themselves, in essence undergoing neolithization in the process. The exogamous, patrilocal marriage pattern tentatively inferred from the stable isotope data could be relevant in such a scenario. If exchange of marriage partners with inland communities was a practice already established in the Mesolithic, and if it continued following the appearance of Neolithic communities in the interior, then a mechanism for the transfer of new ideas and material in the process of neolithization on the Morbihan coast presents itself (cf. Patton (1991) for the Channel Islands). Increasingly, evidence for the early presence of Neolithic communities in interior Brittany is being found (Briard et al. 1995; Cassen and Hinguant 1996; Cassen et al. 1998; L'Helgouac'h and Lecornec 1976). Whether this is occurring through colonization or more local acculturation makes little difference to the present argument, although it may be noted that the site of Le Haut Mée, Ille-et-Vilaine (inland northeast Brittany), radiocarbon dated to 5000–4800 cal B.C., is a clearly intrusive Neolithic manifestation with strong connections—both in the form of the trapezoidal timber longhouse and in the pottery—to the Villenueve-St-Germain group of the Paris Basin Neolithic (Cassen et al. 1998). Taking into account the marine reservoir correction on the AMS dates from Téviec and Hoëdic brings these events into close conjunction; even the main cluster of burials at Téviec becomes ca. 5200 cal B.C., presenting the distinct possibility that the stone cists are actually coterminous with the appearance of Neolithic influences in the region. The lack of pottery at the sites,[7] together with the uncertainties surrounding the evidence for the earliest Breton Neolithic, still make this at best a speculative scenario.

The early dates from Téviec and Hoëdic suggest the continuation of both a Mesolithic economy (as seen in the faunal remains and the stable isotope evidence) and worldview (as seen in the continuity in mortuary practices and use of place), apparently contemporary with the appearance of the earliest Neolithic in Brittany. In fact a period of overlap of some 800 years or more may be indicated. But the chronological relationship between the two "cultures" is still problematic, and a larger series of accelerator dates and isotope analysis on human bone from early Neolithic contexts is needed. A considerable amount of such data from Denmark has shown that the Mesolithic–Neolithic transition is accompanied by a very sharp shift from marine to terrestrial domestic resources (Tauber 1981, 1986); a similar pattern may apply in Britain (Richards and Hedges 1999b; Richards and Mellars 1998; Schulting 1998a; Schulting and Richards 2000; Schulting and Richards in prep). While the pattern is less strong, the beginning of the Neolithic in the Tagus region of Portugal also appears to have been accompanied by a significant dietary change (Lubell et al. 1994). Further work is certainly required, but the data presented here suggest that the situation in Brittany may be more complex. It is essential to sort out these kinds of issues before we can begin to resolve larger concerns regarding the nature of the Mesolithic–Neolithic transition and possible interaction between the groups following the two lifeways.

SUMMARY

The proportionally large series of AMS dates on human bone from Téviec and Hoëdic has permitted far more interesting

[7] A late Neolithic component was present at Hoëdic, but it was reportedly separated from the Mesolithic component by a sterile layer (Péquart and Péquart 1954:11–12).

insights to emerge than would have been the case had only one or two dates from each site been sought. In the present case, such a procedure could easily have produced a very skewed notion of the chronology of the sites. This should serve as a warning—should one be necessary—against relying on a limited number of radiocarbon dates when interpreting potentially complex sites. Indeed, the 14 dates discussed here, while representing a significant proportion of the total number of individuals found at the sites, have raised unexpected questions that may require further dates to resolve. In particular, the dates emphasize concerns over the issue of calibration under circumstances of significant input of marine protein into the diet. Even before any such correction, however, a number of dates clearly fall within what is considered the "Neolithic" period in Brittany, raising questions about the relationship between the "Mesolithic" and the "Neolithic" here, both in the sense of the archaeological entities represented and our use of the terminology. In addition, the surprising gap in time between the use of, in one case, the same grave and, in another case two adjoining graves, requires further investigation. If confirmed, this presents, to say the least, a remarkable circumstance.

The palaeodietary data acquired not only provide important new information but also suggest fruitful new lines of inquiry, further emphasizing the usefulness of the stable isotope technique. The unexpected but real dietary differences observed between individuals from Téviec and Hoëdic show that significant variability in the economy can exist even within a relatively small area. This serves to make the point that not all coastal (or near-coastal in this case) locations necessarily reflect the same degree of use of marine resources, and that a relatively fine level of resolution can be achieved. That being said, the utilization of marine foods at both sites is substantial and can be compared with broadly similar results from the Mesolithic of southern Scandinavia, the west coast of Scotland, and the south coast of Wales. It is becoming increasingly apparent that coastal economies in the Mesolithic *were* coastal in orientation, and were possibly specialized to a considerable degree (and this phenomenon is perhaps not as restricted to the late Mesolithic as often thought). This may be one of the factors that led to a delay in the neolithization of these areas (cf. Zvelebil 1989). The reasons for the final shift, and the extent to which a concomitant change in the subsistence economy is implicated, remain the focus of continued research and debate. The latter question at least is amenable to further investigation using combined stable isotope analysis and accelerator dating. The differences detected between the sexes at both sites provide additional insights into the nature of late Mesolithic societies; further work will be directed toward confirming the interpretation put forward here, that is, that the differences reflect an exogamous, patrilocal marriage pattern. In light of the dating information, this, in turn, has implications for the process of neolithization that merit further exploration.

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