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A tale of two processes of Neolithisation: southeast Europe and Britain/Ireland

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Introduction

1996 saw the publication of Alasdair Whittle's *Europe in the Neolithic: The Creation of New Worlds* – a landmark event for European Neolithic studies. Alasdair's previous publication *Neolithic Europe: A Survey* (1985) already had provided at the time one of the best, most comprehensive and accurate surveys of the vast amount of data coming from thousands of Neolithic as well as Copper Age sites from across the continent. But the 1996 synthesis not only provided updates of research appearing in the intervening years, but also opened up new conceptual horizons, strongly arguing for the importance of a successful marriage between empirical detail and theoretical issues. This is best reflected in the memorable phrase: "Interpretation is unavoidable, central, obligatory" (Whittle 1996: preface).

Europe in the Neolithic: The Creation of New Worlds programmatically challenged some taken for granted views of the Neolithic that had remained ingrained and rarely systematically scrutinized since the days of Gordon Childe: What was the role of indigenous populations of foragers in the transition to agriculture or the Neolithic way of life? Was the change towards the Neolithic caused by migrating populations of farmers who in successive waves replaced sparse forager populations as hitherto held by most of the authors, or should one envisage more complex processes of acculturation and interaction between different groups? How different were the identities of Mesolithic and Neolithic communities? To what extent were Neolithic farming populations fully sedentary as assumed by many even in the context of large tell sites, and what importance did seasonal mobility play for Neolithic people? These are only some of the questions posed in *The Creation of New Worlds*. Twenty years on, much has changed, both in the vastly increased amount of material recovered, but perhaps more importantly in the remarkable advances in archaeological science that has brought much new information to bear on questions concerning the process by which communities became ‘Neolithic’, as witnessed by a series of conferences dedicated to this field, and their resulting publications; again, Alasdair is at the forefront of this new research (e.g., Whittle and Bickle 2014; Whittle *et al.* 2011). In this paper we look at the process of Neolithisation by examining the patterning of stable isotope data in the Mesolithic-Neolithic transition from two ends of the continent: southeast and northwest Europe. The stories we can tell based on the current evidence reveal some differences but also many similarities. The comparative perspective may offer some benefit to our understanding of wider processes while we keep an eye on the detail at both regional and site levels – an important lesson we both learned from Alasdair.

Two processes of Neolithisation

By ‘bookending’ Europe we can compare the process of Neolithisation in two very different environmental and cultural/historical contexts (Figure 1). Southeast Europe sees the earliest appearance of domesticated plants and animals, alongside changes in material culture, in Continental Europe. Britain and Ireland, by contrast, fall near the end of the process, being among the last regions to ‘become Neolithic’ (the only later transition occurs in the far north and east of Europe). By this stage any adaptations to the very different climate of Europe –compared to that found in the origins of domesticated plants and animals in the Near East – will have already taken place, both in terms of genetic and physiological changes to the resources themselves (e.g., Jones *et al.* 2012), and, equally importantly, in terms of the ‘know-how’ required to manage crops and herds successfully. Britain and Ireland also differ in that plants and animals (at the very least) must have been carried across the sea, with the potential for a more directed introduction. In both regions, the question of exactly who was doing the introducing remains, along with ‘how’ and ‘why’?.

Here, we explore some aspects of these questions (though only occasionally touching upon ‘who’) through the use of stable isotope analysis, which is well established in both areas, such that relatively large datasets are available. The data are of varying quality: while the majority are the averages of duplicate or triplicate measurements specifically for palaeodietary investigation, a minority are single runs associated with ^{14}C AMS dating, generally from the Oxford Radiocarbon Accelerator Unit, University of Oxford. These are retained here, since direct dating provides good chronological control, and studies (e.g., Schulting *et al.* 2014) have shown sufficiently good agreement between the two types of measurements for the broad approach being undertaken here. As a means of graphically organising the data for discussion, we divide stable carbon and nitrogen isotope values obtained on human bone and dentine collagen into four quadrants, using a δ^{13}C value of –18‰ on the x-axis and a δ^{15}N value of +12‰ on the y-axis (Schulting 2015a). The upper right quadrant (URQ) reflects varying reliance on marine-derived protein (isotopic values on collagen are biased towards the protein component of the diet), while the upper left quadrant (ULQ) is expected to reflect the use of freshwater aquatic resources, which are enriched in ^{15}N but usually depleted in ^{13}C. The lower left quadrant (LLQ) reflects diets with predominantly C_3 terrestrial plant and animal resources, while the lower right quandrant (LRQ) is expected to be largely unpopulated in ecosystems lacking substantial C_4 resources. Of course this approach masks considerable isotopic/dietary variability within each quadrant, but it does offer a convenient means of structuring and comparing data from different sites and periods in the search for broad trends, as well as providing a simple means of highlighting outliers for further consideration.

Southeast Europe

The transition to a farming way of life is one of the most debated topics in European, and indeed world, prehistory. Southeast Europe and the Balkans (Figure 1) have for a very long time been recognized as key in understanding the initial dispersal of Neolithic ways of living into and across Europe and in devising models that can also be applied to other regions of Eurasia (e.g. papers in Lichter 2005; Özdoğan 2011; Price 2000; Robb 2013; Tringham 2000; Whittle 1996). What has been less agreed upon is whether one should envisage a phased (frontier model), slow (diffusionist model) or fast (migrationist model) spread, conversion of local populations with the arrival of the Neolithic novelties (acculturation model), or a rapid spread of pioneer farmers (leap-frog model), forming enclaves in particularly favourable parts of the wider region (for various versions of existing models see Ammerman & Cavali-Sforza 1973; Biagi *et al.* 2005; Borić 2005; Forenbaher & Miracle 2005; Gkiasta *et al.* 2003; van Andel & Runnels 1995; Whittle *et al.* 2002). Providing complex answers to possibly very complex realities and patterns that the listed possibilities may suggest will depend largely on what the chronology of the Neolithic spread suggests both on sub-regional and pan-regional scales.

At present, we are still lacking datasets that would easily discriminate between the above possibilities. Various targeted dating projects in the past were reasonably successful in providing answers about the pace and directionality of the Neolithic spread in the Balkans (e.g., Forenbaher and Miracle 2005; Krauss *et al.* 2014; Whittle *et al.* 2002). However, often such patterns depend on a single early date from a particular site within a highly selective sample of dated sites and contexts. For instance, on the basis of a handful of single measurements per site, Biagi *et al.* (2005) suggest that Early Neolithic enclaves were formed in the northern parts of southeast Europe, thus indicating rapid Neolithic insertion in certain parts of the region. Yet, Early Neolithic dates that have previously been obtained in the central Balkans hint at a more gradual spread.

Apart from insights that the chronology of the Neolithic spread provides, in the past two decades, stable isotope data on human bone have provided an important proxy for the characterisation of the Neolithisation process. The skeletal record of the Danube Gorges, where a large burial sample exists in the excess of 500 individuals encompassing Mesolithic and Neolithic periods, saw the first application of stable isotope analysis (Bonsall *et al.* 1997) and continues to play a decisive role in our understanding of changes in the subsistence base of Mesolithic foragers versus Neolithic farmers in southeast Europe. Other areas of the region offer a far patchier stable isotope record of human diets. Yet, data have accumulated with which to attempt to characterize and compare the subsistence base of Mesolithic and Neolithic communities in different parts of southeast Europe. The coverage is still sporadic and should improve in the future even though the absence of human remains in some areas will remain an obstacle in the absence of new discoveries.

Here, the approach will be to look at both the broad-scale, pan-regional patterns and to zoom in on specificities of particular sequences. Existing stable isotope data on human bones are organized with a mixed set of criteria: according to their location, geographic affordances (coastal/inland/riparian), temporal slices (Mesolithic, Mesolithic-Neolithic transition and Early Neolithic), and, exceptionally, in the case of the Danube Gorges sequence where a large number of stable isotope data are available, neonates are separated from adult individuals. Hence, the existing dataset (Table 1) is organized into the following groups marked by different symbols: eastern Adriatic coastal zone Mesolithic (N = 6), eastern Adriatic coastal Early Neolithic (n = 9), Greece coastal Early/Middle Neolithic (Franchthi, n = 11), Greece inland Mesolithic (Theopetra, n = 1), Greece inland Early/Middle Neolithic (Theopetra, n = 11), southeast European inland Mesolithic (n = 2), southeast European inland Early Neolithic (n = 36), the Danube Gorges Early to Late Mesolithic (n = 129), the Danube Gorges Mesolithic-Neolithic transition phase (n = 37), the Danube Gorges Mesolithic-Neolithic transition phase neonates (n = 14) and the Danube Gorges Early Neolithic (n = 31). In total, carbon and nitrogen isotope values of 287 individuals from across southeast Europe are available (Figure 2).

Figure 2. Plot of $\delta^{13}C$ and $\delta^{15}N$ values on Mesolithic and Early/Middle Neolithic human bone collagen from southeast Europe (n = 278). (sources: Table 1).

There are two distinct groupings at the pan-regional scale, with most individuals falling either into the upper or lower left quadrants. This is consistent with the expected distribution of Mesolithic freshwater fish-dominated diets throughout the Mesolithic of the Danube Gorges and largely terrestrial diets in the Early Neolithic of the inland regions of southeast Europe, respectively. What is less expected is that based on stable isotope data alone during the Mesolithic of the coastal eastern Adriatic region (within 10 km of the coastline), dietary practices were dominated by terrestrial resources, presumably hunted game, with only one (infant) individual from Vela Spila Cave on the island of Korčula falling into the expected diet of coastal areas with a higher contribution of marine resources. Yet the obtained dietary signature of the infant presumably at least partly reflects its mother's diet via nursing. There are several other Mesolithic individuals which are close to the –18.0‰ cutoff value in the LLQ of the scatterplot and that may indicated limited consumption of marine-derived foods. In keeping with the pattern seen in the Mesolithic of this region, analyzed human samples from Neolithic coastal sites in the Eastern Adriatic region suggest that diets were largely terrestrial (Lightfoot *et al.* 2011), and it can be assumed that domesticates might have started to play an important role in subsistence (e.g., McClure 2013). One should note that current conclusions about Mesolithic-Neolithic dietary pathways for this region are based on a relatively small sample of analyzed individuals that may or may not be representative of underlying patterns and it would be important to take here into consideration the significant presence of fish remains in faunal assemblages of both Mesolithic (Vela Spila) and Neolithic (Vela Spila Korčula, Kargadur, Vela Špilja Lošinj) sites (cf. Rainsford *et al.* 2014).

A possibly similar pattern of dominantly terrestrial diets at coastal sites has been noted as the Mediterranean Basin-wide trend in the Mesolithic (Schulting 2015a: 161 and references therein) and might also have characterized coastal Greece. With their analysis currently underway, this picture may change once isotopic data become available for the Mesolithic human remains from the important coastal site of Franchthi Cave (M. Richards, pers. comm.). A number of individuals with stable isotope data assigned to Neolithic levels of Franchthi Cave suggest largely terrestrial diets with one individual in the URQ of the scatterplot with the δ^{13}C value of –17.0‰ and δ^{15}N value of 14.1‰ suggesting a moderate intake of marine resources (Papathanasiou 2011: 93, Table 5.1). One other individual is on a lower trophic level, in the LRQ, with a δ^{13}C value of –17.8‰ still probably indicative of some marine contribution to diet. Similar to the Adriatic coastal zone, a number of stable isotope measurements at Neolithic Franchthi do tend to cluster closer to –18.0‰, which may suggest some minor and sporadic contribution of marine foods in diet. Regarding inland Mesolithic Greece, there is only one currently isotopically analyzed individual from the site of Theopetra Cave that, as might well be expected, points to a primarily terrestrial diet and is indistinguishable from the tightly clustered Neolithic values, suggesting terrestrial C_3 dietary pathways, with the likely importance of domestic plants and animals in the latter case (Papathanasiou 2011).

To date, there are only two individuals directly dated to the Mesolithic in inland southeast Europe, both from the Carpathian Basin. One is a human skull associated with the Early Neolithic occupation at Maroslele-Pana in Hungary with two determinations (OxA-9403: 7765±55 BP; OxA-X-922-30: 7680±70 BP) clearly confirming a Late Mesolithic assignment in the first half of the 7th millennium BC (Borić 2005; Whittle *et al.* 2002). The associated stable isotope values fall in the LLQ, although the slightly elevated δ^{15}N value of 11.5‰, could be indicative of some consumption of freshwater fish at this locale close to the banks of the Maros River. The interpretation of the context of this discovery remains uncertain, with the presence of a Mesolithic-age skull in Early Neolithic occupation levels with other Neolithic individuals at the site dated to the beginning of the sixth millennium BC. Two possibilities can be mentioned: (a) these are human remains deposited here in the Late

Mesolithic and accidentally disturbed during the Early Neolithic occupation of the site, or (b) these remains were intentionally brought to this location by Early Neolithic groups as possible human relics from some other region.

The second Mesolithic individual comes from Topole-Bač in Serbia, with one of the two AMS-dated individuals in what is a double burial to the end of the 8th and the beginning of the 7th millennium BC (OxA-8504: 8085±55 BP). This result is surprising as the other individual is also directly AMS-dated but to the end of the 7th millennium BC, suggesting an Early Neolithic burial context. Both burials are articulated primary inhumations placed in crouched positions on their lateral right sides symmetrically back-to-back which strongly suggest the contemporaneity or at least close awareness of the two interments (Borić 2015a). The stable isotope results for both individuals suggest reliance on terrestrial C_3 pathways despite the proximity of the site to the banks of the Danube River, so that it is unlikely that a freshwater reservoir effect can explain the discrepancy. In order to be able to accept the AMS measurement and isotope values for the mentioned individual from Topole-Bač as indicative of Mesolithic dietary patterns, it will be necessary to re-date these burials in the future.

Most of the inland southeast European Neolithic sites with AMS dates and associated stable isotope data come from the Carpathian Basin of Hungary, Serbia and Croatia, with the exception of Jaričište in western Serbia and Blagotin in central Serbia. At each of these sites only a small number of primary burials were found with crouched inhumations placed on their right or left sides being the norm (Borić 2015a). Despite the fact that most sites in the Carpathian Basin are found close to the major waterways of the Danube, Sava, Tisza, Maros and Körös Rivers, a consistent pattern of largely terrestrial diets can be suggested for the earliest Neolithic inhabitants of the region, and this pattern by and large matches the consistent presence of predominantly domestic (ovicaprid-dominated) taxa in Early Neolithic faunal assemblages across the region (see Orton 2012 for a review). An elevated $\delta^{15}N$ value of 14.1‰ from Vukovar-Gimnazija in Croatia (Lightfoot *et al.* 2011) obtained on an infant presumably reflects a nursing signal that contributes to ^{15}N enrichment due to recycled nitrogen, and with breastfeeding babies enriched by one trophic level (with a mean value of between 2 and 4) above the mother. If, by contrast, a neonate died during birth, its $\delta^{15}N$ value would reflect that of the mother (cf. Dittman and Grupe 2000).

Elevated δ^{15}N values are also present in several individuals from a multiple burial found at the lowermost levels at Vinča-Belo Brdo, located on the Danube banks near Belgrade. One is dated to the mid-6th millennium BC and it is assumed that other individuals fall within the same timespan. At Vinča, the δ^{15}N values alone would suggest some consumption of high-trophic-level foods, presumably fish from the nearby river. However, sulphur isotope (δ^{34}S) analysis of five individuals from this multiple burial indicate that this conclusion may need revisiting. It may be that δ^{34}S is more sensitive to the relative role of freshwater fish in dietary protein (cf. Privat *et al.* 2007; see below). Nehlich *et al.* (2010) suggest that the δ^{34}S values at Vinča, which range 2.3–3.7‰ are indicative of largely terrestrial diets. This also implies no need for any correction of the radiocarbon dates for the freshwater reservoir effect (see Borić 2015b: footnote 98). On the basis of a larger sample of δ^{34}S measurements on human and animal remains from the sites in the Danube Gorges area (see below), Nehlich *et al.* (2010: 1136) conclude that δ^{34}S values below 6‰ reflect primarily terrestrial sources, but there remains a need to reconstruct locally available δ^{34}S values by analyzing faunal remains from Vinča. If fish played a minor role in the diet of individuals from Vinča, what explains the elevated δ^{15}N values? We may speculate that in this context manuring has caused enriched ^{15}N levels (Bogaard *et al.* 2013), and this possibility should be taken into account, along with the contribution made by young domestic animals with elevated δ^{15}N values due to nursing (Nehlich *et al.* 2010; Nehlich and Borić 2015).

Figure 3. Plot of δ^{13}C and δ^{15}N values on Mesolithic and Early Neolithic human bone collagen from the Danube Gorges area (n = 211). (sources: Table 1)

The micro-region of the Danube Gorges has seen several dedicated stable isotope projects and also provides the most representative and temporally differentiated and fine-grained sample in southeast Europe with which to observe changes in dietary regimes in the transition from the Mesolithic to the Neolithic. A suite of isotopic analyses (^{13}C, ^{15}N, ^{34}S, ^{87}Sr/^{86}Sr) have been applied to skeletal material from various sites (Bonsall *et al.* 1997, 2000; 2015a; Borić *et al.* 2004; Borić and Price 2013; Cook *et al.* 2009; Grupe *et al.* 2003; Nehlich *et al.* 2010). The obvious research advantage here is that a large number of human remains is available for analysis along with a relatively consistent temporal coverage of the

Mesolithic and Early Neolithic periods. However, it should be noted that Early Neolithic human remains are less abundant than Late Mesolithic remains. There are now close to 300 AMS measurements from almost all of the sites dating to the discussed periods, with many on human remains (Bonsall *et al.* 2015a; Borić 2011). Various features and burials from Lepenski Vir have now been dated by over 100 radiocarbon measurements (Borić *et al.* forthcoming). Stable isotope analyses in conjunction with AMS dating were also key in recognizing the aquatic reservoir effect that affects radiocarbon dates on human, dogs or fish, or any organisms that feed on fish due to the intake of carbon from a reservoir different than the atmosphere, thus causing the deposition of 'old carbon', with the necessity of calculating age offsets (Cook *et al.* 2002; cf. Borić 2011; Borić and Miracle 2004). Hence the region plays an important role in gaining a better handle over various methodological issues, in part due to the unique and robust sample.

Most of the individuals grouped under Early to Late Mesolithic Danube Gorges, which in this regional context encompasses the period from the beginning of the Holocene to the first appearance of Neolithic settlement in the wider region of the central Balkans around 6200 cal. BC, are found in the ULQ, suggesting a substantial contribution of freshwater resources to diet (Figure 3). While a finer-grained temporal resolution is possible by differentiating at least Early from Late Mesolithic groups regarding the pattern of stable isotope data, this is necessary for the discussion here, which primarily focuses on the Neolithisation process. It suffices to say that only two individuals – both from Vlasac – have values below 12.0‰: a 10-12-year-old child (burial 51, $\delta^{15}N$ = 9.9‰) and a six-year-old child found with an adult (burial 66a, $\delta^{15}N$ = 10.1‰) (Borić *et al.* 2004). Both burials are found in the context of the Late Mesolithic layers at Vlasac (Borić *et al.* 2008) but neither has been directly AMS-dated. It is noteworthy that both skeletons exhibit flexed lower limbs, often indicative of later, crouched Neolithic body postures. However, Early Mesolithic individuals at the sites of Padina and Lepenski Vir also have positions with lightly flexed lower limbs and so until direct AMS dates are obtained on these two individuals it will remain uncertain how to interpret their outlier stable isotope values. One individual from Hajdučka Vodenica (burial 19/20) borders on the URQ, which would suggest the consumption of marine-derived resources, and this can be explained by the contribution of migratory sturgeon (likely beluga *Huso huso*) to diet, since various species of sturgeon are know to have come up the Danube to spawn and were caught in the region on a large scale historically (Borić 2001, 2003; Borić *et al.* 2004).

During the Mesolithic-Neolithic transition phase (ca. 6200–5950 cal. BC), two individuals in the Danube Gorges area are found in the URQ of the scatterplot, again suggestive of marine dietary input through the consumption of anadromous species (burial 20 from Hajdučka Vodenica and burial H63 from recent excavations at Vlasac: Borić 2011; Borić *et al.* 2014). Yet, important changes are now evident in the distribution of the individuals assigned to this phase. One should note that here neonates, which comprise a large group of burials at Lepenski Vir (Borić and Stefanović 2004; Stefanović and Borić 2008), plotted separately from children and adults to differentiate the nursing signal present in some of the values obtained for neonates from this phase. Of 37 children and adults dated to the Mesolithic-Neolithic transition phase from five different sites in this region, seven individuals have $\delta^{15}N$ values below 12‰. All of these individuals come from Lepenski Vir (Burials 7/I, 14, 26, 54a, 54b, 99, 122: Borić *et al.* 2004; Borić and Dimitrijević 2009). An additional burial from the same site exhibits a borderline value of 12.2‰ (Burial 93). The concentration of these individuals at Lepenski Vir is notable but not surprising as the site offers the best record for the transitional aspects of the settlement and burial record in the regional. This is also the period during which hybrid cultural aspects are found at Lepenski Vir, with the introduction of Neolithic novelties apparent in material culture (ceramics, polished stone axes, new types of ornaments and osseous tool technologies, Borić 2011; Borić and Cristiani in press). It has been suggested that this is a period of intense contacts and exchanges between the fisher-foragers in the Danube Gorges and the first farming groups from the surrounding areas (Borić *et al.* 2014).

There is also a likely chronological overlap between Mesolithic traditions and ways of living at upstream sites in the Danube Gorges area *sensu stricto*, and the downstream area of the region open to the Wallachian Plain where for the first time newly founded Early Neolithic sites seem to have been established towards the end of the 7th millennium BC (see below). This scenario is strongly supported by the increase in the presence of non-local individuals based on strontium isotope analysis (Borić and Price 2013). While there is only one case of a clear-cut correspondence between the $\delta^{15}N$ value of 9.5‰ and a non-local strontium ratio individual (burial 122, an isolated juvenile skull placed between the limestone trapezoidal floors of two buildings: Borić and Dimitrijević 2009), perhaps significantly other non-local individuals assigned to this phase were also reported in the context of the following burials with lower $\delta^{15}N$ values: 7/I (a disarticulated skull marked as 7/II was non-local), 14 (primary burial 13 found in the same burial pit was non-local), 54a and 54b (primary burial 54e found in the same burial location was non-local). In addition, burial 26 with a lower $\delta^{15}N$ value is possibly non-local. These data tentatively suggest that reduced trophic levels, more consistent with dietary pathways based on the consumption of terrestrial C_3 species, found at Lepenski Vir during the period of cultural changes and contact with Neolithic groups are probably related to the (influence of) non-local individuals being buried at this locale and which probably spent part of their lives here too. The presence of non-local individuals with dietary habits different from those of local foragers might have started influencing the latter in the direction of a reduced consumption of fish. However, it is striking that there are no obvious and marked signs of non-local identity in the mortuary arena as most of the burial rites during this transitional phase are consistent with the tradition of Late Mesolithic mortuary customs: an extended supine position parallel with the Danube and heads pointing downstream often in close association with architectural features of trapezoidal buildings, contrasting with the Early Neolithic flexed position both without and outside and Gorges.

Considering isotope values for neonate burials found at Lepenski Vir, several neonates show enriched values at the top of the scatterplot indicative of the nursing signal of babies from mothers with elevated $\delta^{15}N$ values while in some other cases neonate values directly overlap with higher trophic levels of adult individuals and may suggest either that these children died at birth, thus reflecting isotope signatures of the mothers in the ULQ of the scatterplot, or these values are still consistent with the effect of nursing signals but come from mothers with lower $\delta^{15}N$ values also documented during this phase.

The onset of the Early Neolithic (ca. 5950–5500 cal BC) in the Danube Gorges saw significant changes that were, however, already under way during the Mesolithic-Neolithic transition phase. This is the period of consolidated Neolithic presence at all of the locales previously occupied in the Mesolithic, along with the likely establishment of new settlements (Borić 2011). However, the burial record is confined to a few sites and the only larger group of burials found at a site inhabited in the Mesolithic that can confidently be dated to the Early

Neolithic comes from Lepenski Vir. Two other locations yielded a relatively large number of burials that can be associated with the Early Neolithic populations in this region: Ajmana and Velesnica, located farther downstream from the downstream entrance into the Danube Gorges. Yet, at least some of these individuals might have chronologically overlapped the duration of the transition period in the region (Bonsall *et al.* 2015a; Borić 2011; Borić and Price 2013). These might have been the groups of Neolithic farmers that came into contact with and started influencing autochthonous Mesolithic populations farther upstream on the Danube (see above). All of the individuals with stable isotope values from Ajmana and Velesnica exhibit dietary signatures indicative of terrestrial diets, probably in great part derived from the consumption of domestic animals and cereal plant foods, but we should not entirely exclude fish consumption during this period. Of 13 analyzed individuals placed in the same multiple burial location at Ajmana, three are non-local based on strontium isotope ratios (Borić and Price 2013). At Lepenski Vir, there are more individuals with likely terrestrial diets during this period, and these by and large correspond with non-local strontium ratios (burials 8, 17, 19(3), 20, 32a and 88), but one non-local adult female (burial 66) has a δ^{15}N value of 14.9‰ indicative of substantial fish contribution to diet (Borić and Price 2013). Moreover, a number of other individuals assigned to this phase (burials 19, 31a, 32b, 42a, 44, 51, 55a, 73 and 74), some of which are primary burials in crouched positions indicative of Neolithic burials practices, maintain high δ^{15}N values and one would assume that again consumption of fish is responsible. However, recent work on sulphur isotopes in this region may challenge this assumption and may complicate the story.

The previously mentioned study by Nehlich *et al.* (2010) examined sulphur ^{34}S isotopes on a select number of individuals from several sites in the Danube Gorges in order to better understand the role of fish in diet. Sulphur in bone collagen derives from the essential amino acid methionine. Marine organisms have δ^{34}S values of ca. 20‰ and terrestrial organisms from –5 to 10‰ (Krouse 1980). Since fish has greater proportion of methionine than terrestrial mammals, the consumption of even small amounts of fish are likely to be recorded in consumer δ^{34}S values (Nehlich *et al.* 2010: 1137). The dietary reconstruction regarding the relative contribution of fish to human diet in the Danube Gorges area established a baseline by analyzing fish and mammal remains from the same sites. Based on the currently published data, δ^{34}S values below 6‰ reflect primarily terrestrial protein sources, values between 6 and 10‰ reflect mixed diets from both aquatic and terrestrial systems, and those over 10‰ point to diets dominated by fish. While a more robust sample is needed for more conclusive results, some interesting patterns can be observed primarily concerning chronological differences. The chronological ordering is based on both direct AMS measurements for some of the analysed individuals (burial 17 from Vlasac; AMS-dated burial 15 from Padina is found in the same position and next to burial 16, suggesting their contemporaneity; burial 12 from Padina; burial 8 from Hajdučka Vodenica; Borić 2011) and on their stratigraphic position.

Figure 4. Comparison between $\delta^{34}S$ and $\delta^{15}N$ values on the same individuals from the Danube Gorges area order by main chronological periods (n = 19). Source: Nehlich *et al.* 2010.

Plotting $\delta^{34}S$ values for each of the measured individuals against their suggested chronological period (Figure 4A), a group of Early Mesolithic individuals from Padina, Lepenski Vir and Vlasac is clearly separated from the Late Mesolithic sample as having a limited contribution of fish in their diet (Borić 2012: 28; Bonsall *et al.* 2015b). Moreover, while the $\delta^{15}N$ values for this group of Early Mesolithic individuals are largely indistinguishable from the $\delta^{15}N$ values of Late Mesolithic individuals (Figure 4B), the $\delta^{34}S$ values apparently tell a different story and this calls for the need to use sulphur isotope analysis as a complement to the routine use of carbon and nitrogen in palaeodietary reconstructions. Further research focussed on more detailed dietary reconstructions using FRUITS Bayesian modeling (Fernandes *et al.* 2014) that can provide estimates of relative contribution of different dietary sources (e.g. Nehlich and Borić 2015). There is currently only one individual, Burial 74 from Lepenski Vir, with a published $\delta^{34}S$ value that can be attributed to the Early Neolithic phase and while its $\delta^{15}N$ value would suggest a diet with significant contribution of fish, the $\delta^{34}S$ value would suggest a very limited consumption of fish, which would be consistent with the expectation of more terrestrial C_3 dietary pathways in the Neolithic.

Independent evidence for the introduction of new dietary practices at the beginning of the 6th millennium BC is found in the presence of caries on the teeth of two non-local women at Lepenski Vir (burials 32a and 88), suggesting that starchy foods were an important part of their diets (Grga 1996; Radović 2013). The arrival of new resources is also indicated by spoons made from cattle bones, which have been found at several Early Neolithic sites across the Balkans (Nandris 1972). Some examples were found at the site of Schela Cladovei (Bonsall 2008: Fig. 10.9) but not at other sites, including phase III deposits at Lepenski Vir.

The previous discussion suggests that complex modes of subsistence must have been practiced in the Danube Gorges, but this perhaps also applies to other, adjacent regions of the Balkans and to southeast Europe as a whole. Rather than viewing these modes of subsistence as immutable, it is likely that individual adjustments and alterations in food choices shaped the complex reality that combined the two different foodways heuristically identified as “Mesolithic” (game and fish-dominated) and “Neolithic” (dominated by domestic animal and plant foods). For the actors of these processes, culinary and perhaps ritual exchanges, or taboos and prohibitions regarding the consumption of certain animal or plant species coupled with the symbolic, ideological and social connotations of particular foodways must have been of paramount importance.

While many more questions remain to be answered in this regional context, especially concerning the implications of $\delta^{34}S$ data on current paleodietary reconstructions or the exact role of marine foods in coastal areas in both the Mesolithic and Neolithic, a wider regional pattern of stable isotope data is indicative of widespread and seemingly quick adoption of more terrestrially based dietary pathways with the arrival of Neolithic groups, practices and materialities. However, in the Danube Gorges – the only area where the shift can be followed with a robust sample and fine-grained chronological control – it seems that the arrival of new people, probably originating in Neolithic groups, among foragers sowed the seeds of change in the traditional, Late Mesolithic reliance on largely freshwater and some anadromous fish. If we consider this microregion as representative of the nature of the transitional process and forager-farmer interactions in southeast Europe as a whole, the change in the consumption of fish was not wholesale and immediate. Yet, by the mid-6th millennium BC, even those groups that inhabited locales suitable for fishing, such as Vinča, acquired the majority of their dietary protein from terrestrial sources, likely domestic animals and plants. This period also coincides with the time when the whole area of the Danube Gorges and locales that were used in the previous millennia for intense fish harvesting were abandoned and possibly considered marginal among Middle Neolithic

Vinča culture groups, with their increasing focus on cattle-breeding (Borić 2011; Orton 2012).

Britain and Ireland

One of the first challenges to the cultural-historical model for the transition to agriculture in Europe, including Britain, dominating much of the twentieth century, was from Robin Dennell (1983), who suggested, rather speculatively, the possibility of some local animal domestication (limited to cattle and pig in the context of Britain, which has no native wild sheep or goats). A more sustained critique of the 'Neolithic Revolution' model in a British context came in the late 1980s, persisting throughout the 1990s and beyond. This position had two main elements. Firstly, it downplayed the importance of an economic shift towards the reliance on domesticated plants and animals in the Early/Middle Neolithic, ca. 4000–3000 cal BC. While it was incontrovertible that wheat, barley, cattle, pig, sheep and goat were present, these were seen as exotic foods used largely in ceremonial contexts, with the bulk of the subsistence economy still reliant on hunting and gathering (Armit and Finlayson 1992; Thomas 1991). Secondly, it emphasised the importance of the indigenous, hunter-gatherer population as active agents in the process of neolithisation, in its most extreme expression seeing no need for any movement of people from the Continent to Britain at all (Thomas 2003; 2007). Without rehearsing the arguments here (see Rowley-Conwy 2004; 2011; Schulting 2008; 2013; 2015b; Sheridan 2010), this position seems untenable, particularly in the light of the newly emerging genetic evidence (Cassidy *et al.* 2016; Mathieson *et al.* 2015).

Ironically, at the same time that the debate over the (non)importance of domesticated resources was reaching its resolution largely in favour of the negative, some of the first stable carbon and nitogen isotope analyses of human bone – the utility of which in terms of addressing dietary shifts across the Mesolithic-Neolithic transition was initially demonstrated in Denmark (Tauber 1981; 1986) – were becoming available (Schulting 1998; Schulting and Richards 2002a; b; Richards and Hedges 1999a; Richards *et al.* 2003). From the outset, it was clear that this evidence was more consistent with a rapid and, if not complete, then certainly a major shift in subsistence towards the use of terrestrial resources in coastal areas of Britain, just as had been seen previously in Denmark. Taken in context, and given the attested presence of domesticated plants and animals (the latter overwhelmingly dominating every known Neolithic faunal assemblage; Schulting 2013a), it seems logical to interpret this as a shift to a reliance on farming. There is little evidence for any experimental phase; rather, just as with the knowledge to produce finely made, thin-walled pottery, and to build mortuary monuments in keeping with the design concepts of earlier prototypes on adjacent parts of the Continent (Sheridan 2007; Sheridan *et al.* 2008), farming appears fully formed, being realised by highly competent practitioners. Both Britain and Ireland witnessed widespread integrated farming systems in the Early Neolithic, incorporating stable arable fields (Bogaard and Jones 2007), extensive field systems (Caulfield *et al.* 1998) and domestic animal herds, the latter emphasising the central importance of cattle for meat and prestige (Schulting 2008; 2013a), as well as for milking (Copley *et al*. 2005; Cramp *et al.* 2014) and manure (Bogaard *et al.* 2013).

Stable isotopic data have been steadily accumulating over the last decade, though with a strong Neolithic bias (Figure 5). There is very limited human skeletal material from the Mesolithic – some new results are available from inland sites, but since these diets are based on terrestrial resources, they offer little insight into the process of neolithisation (Schulting 2013b). Recent excavations at Foxhole Cave, Gower, south Wales, have provided a small number of isolated human bones and teeth that have been directly ^{14}C-dated to the Mesolithic, with stable isotope values continuing to support a pattern of the significant use of marine resources at this time, compared to little or no evidence for those elements dated to the earlier Neolithic from the same site (Schulting *et al.* 2013a). Finally, the identification using ZooMS of small human bone fragments from Cnoc Coig, Oronsay, has provided important new stable isotope data, though it is not clear how many new individuals are represented, given the scattered nature of the material (Charlton *et al.* in press).

The overall pattern for the Mesolithic shows considerable isotopic, and hence dietary, variation even in coastal/near-coastal locations, although the great majority of values lie in the URQ, indicating varying reliance on marine resources, ranging from moderate, balanced use to practically complete dependence. Emphasising this is the strong positive correlation between δ^{13}C and δ^{15}N values ($r^2 = 0.814$). The three individuals falling just within the LRQ were presumably exploiting low-trophic-level marine foods. Another two or three individuals, however, appear to have had entirely terrestrial diets (LLQ) even though their remains were found in coastal locations. These may have been recent arrivals to the coast;

also, none are complete burials, and one element, an ulna, appears to have been butchered (Schulting *et al.* 2015).

By contrast, there is a substantial amount of new evidence for the Neolithic, so that we are now in a much better position to look at isotopic variability across Britain and Ireland. Most notable are the results from Orkney and Shetland, given their location surrounded by seas rich with fish and sea mammals. Despite this, the stable isotope results from the chambered tomb of at Quanterness, Orkney, indicate minimal use of marine resources (Schulting *et al.* 2010). The mammalian fauna are also completely dominated by domestic animals. Fish do appear to have featured in the diet, but in what must have been a decidedly minor capacity. A rather different situation is seen at Sumburgh, Shetland (Montgomery *et al.* 2013), where individuals show variable though generally still minor contributions from marine foods, with only one sample falling in the URQ. That this is in fact the result of consuming marine foods is clear from the reasonably strong correlation coefficient (r^2 = 0.582). Moreover, incremental analyses of tooth dentine here revealed that marine foods did feature more strongly for short periods – perhaps some months – in some individuals, who, interestingly, tended to die at a younger age than those retaining more terrestrial diets throughout childhood (Montgomery *et al.* 2013). As suggested by the authors, the episodic use of marine foods here may be related to crop failures, pests, spoilage and diseases striking animal herds: all occurrences well attested in the historical record (Jordan 1996). What is perhaps most striking about Sumburgh is that people were attempting to farm here at all, rather than relying on the locally available marine resources. Presumably this speaks to the cultural importance of maintaining a farming identity (cf. Sjögren 2003).

To the Orkney and Shetland results can be added data from a number of locations around the coasts of mainland Britain, supplemented by a much smaller dataset from coastal Neolithic Ireland. The reason for the focus on coastal sites relates to the ability of $\delta^{13}C$ and $\delta^{15}N$ measurements to distinguish between essentially terrestrial diets, and diets with any significant input of marine foods (by which is meant a contribution on the order of 5-10% or more of dietary protein). The subsidiary argument that, in the Neolithic, such terrestrial diets are in fact based on domesticated crops and animals relies on the following points: 1) earlier Neolithic faunal assemblages are all dominated by domesticated animals, regardless of their location (Schulting 2013b); 2) a sudden shift to a reliance on wild terrestrial resources in coastal areas in the Neolithic makes little sense (*contra* Thomas 2003), given the previous reliance on coastal resources by hunter-gatherer communities, and moreover would probably be unsustainable given inferred higher Neolithic populations levels; and 3) lipid residues from Neolithic pottery from coastal locations also show an overwhelmingly terrestrial signal, and furthermore suggest the importance of dairying from the outset, both in southern and northern Britain (Copley *et al.* 2005; Cramp *et al.* 2014).

Figure 5. Post-weaning human bone/dentine collagen $\delta^{13}C$ and $\delta^{15}N$ values from coastal/near-coastal Mesolithic (n = 31) and Neolithic (n = 187; Sumburgh n = 14) sites in Britain and Ireland (sources: Table 2)

Confirming previous research (Richards *et al.* 2003; Schulting 2013a), it is clear that coastal Neolithic diets (including those in Orkney) were overwhemlingly focussed on terrestrial resources. There is no positive correlation between $\delta^{13}C$ and $\delta^{15}N$ ($r^2 = 0.005$), one of the hallmarks of the consumption of marine protein (Richards and Hedges 1999b). Only two adults from Quanterness exhibit $\delta^{15}N$ values above 12‰, but without any concomitant increase in $\delta^{13}C$, suggesting that marine foods are unlikely to be the explanation here (see below). Moreover, it is seems that this pattern persists throughout the entire Neolithic of Britain and Ireland, from ca. 3900 to 2500 cal BC (Figure 6). Few $\delta^{13}C$ values are higher than −19.0‰ and of these all but one is from Sumburgh, where farming must have been a riskier proposition (Montgomery *et al.* 2013), as indeed it is today. The other exception (from Embo, north Scotland) is also a clear Late Neolithic outlier, removed by over three standard deviations from the $\delta^{13}C$ mean of −20.8 ± 0.6‰ (n = 231, including AMS measurements).

Figure 6. Human bone/tooth collagen $\delta^{13}C$ values from British and Irish Neolithic coastal and near-coastal sites (within 10km of the modern coast or estuary) plotted against the average of the 95.4% range of the calibrated radiocarbon date (n = 203; sources: Table 2).

This is not to say that farming was everywhere the same across Britain and Ireland (Figure 7). Farming practices have always varied across both islands and continue to do so today. But, in the light of the multiple lines of evidence alluded to above (human collagen and pottery lipid stable isotope analyses, faunal assemblages, arable weed ecology), such regional differences are best considered as variations on a decidedly farming theme.

Nowhere is there evidence for the continued *reliance* on wild resources as the major part of the subsistence economy. A simple division of the available human isotopic data from both coastal and inland locations in four modern regions – Scotland, Wales, England and the island of Ireland – provides a preliminary means of investigating regional variability in Neolithic diets (excluding $\delta^{13}C$ results obtained through AMS measurements and a small number of young children with elevated $\delta^{15}N$ values likely reflecting a nursing signal). The results demonstrate that there are clear isotopic differences regionally (Figures 7 & 8; Table 3). Differences are assessed using ANOVA with Bonferroni post-hoc tests ($\alpha = 0.05$). Perhaps the most striking and surprising result is that inland Irish $\delta^{13}C$ values are significantly lower (by ca. 1‰) than seen anywhere, coast or inland, in Scotland, England and Wales. Yet $\delta^{15}N$ results are the highest, significantly so for all comparisions except coastal Scotland. The coastal Scottish (even excluding Sumburgh) and coastal English data are significantly elevated in $\delta^{15}N$ (by 0.5–1‰) above coastal Wales and Ireland. Coast-inland comparisons are only possible for England and Ireland, since Wales and Scotland (with a single exception) lack inland sites with bone preservation. Significant coast-inland differences are seen for both isotopes in the Irish data, but while coastal $\delta^{13}C$ values are higher, $\delta^{15}N$ values are lower, which is the opposite of what would be expected with the consumption of marine foods. This difference is driven entirely by Poulnabrone, which has surprisingly low $\delta^{15}N$ values (Ditchfield 2014). In England, coastal $\delta^{13}C$ values are on average higher than inland values but by only 0.3‰, while $\delta^{15}N$ values are higher by ca. 0.6‰. However, this is due entirely to a single site, Coldrum, Kent, where again there is no associated elevation in ^{13}C, making the consumption of marine resources an unlikely explanation (Wysocki *et al.* 2013). Some contribution of freshwater fish has been suggested (*ibid.*), but this also seems improbable, and an alternative is suggested below.

Figure 7. Human bone/tooth collagen $\delta^{13}C$ and $\delta^{15}N$ values from inland and coastal Neolithic sites in Ireland, Wales, England and Scotland (n = 377; sources: Table 2).

The interpretation of these differences is by no means clear, and a full investigation is beyond the scope of this contribution (for one thing, some of the measurements were made in different laboratories and others were made nearly two decades apart, and it is possible that this in itself is a source of some variability). However, a few preliminary observations can be made. Firstly, confirming the pattern noted above, all regions are consistent with a predominantly ‘terrestrial’ diet. This is seen in the overall coastal δ^{13}C average of -20.8 ± 0.6‰, which is essentially identical in all regions with the exception of Ireland, and especially its inland sites. The fact that the Irish data are significantly ^{13}C-depleted is more likely to reflect an environmental signal than a dietary difference, although this requires further exploration, as do the higher δ^{15}N values. This combination (depleted ^{13}C and enriched ^{15}N) is often interpreted as reflecting the use of freshwater resources (e.g., fish and waterfowl), but there is very limited archaeological or zooarchaeological evidence for this, and indeed Irish waters are relatively impoverished in freshwater fish compared to Britain.

Figure 8. Average ± 2 standard errors for δ^{13}C and δ^{15}N values on human bone/tooth collagen from inland and coastal Neolithic sites (n = 363, excluding Sumburgh; sources: Table 2)

The comparatively high δ^{15}N results from Scotland are heavily biased towards Orkney, though even here the evidence for the consumption of marine foods is limited (Schulting and Richards 2009; Schulting *et al.* 2010). The other way to explain elevated δ^{15}N values is through a contribution of freshwater fish and/or waterfowl, but such resources would not have been particularly plentiful in either Orkney or on the west coast of Scotland, whence much of the remaining data derive. The single inland individual for Scotland, from a chambered tomb at Cultoquhey, Perth and Kinross, is notably lower in δ^{15}N (7.7‰) than all other Scottish values. The interpretation of this is uncertain, given that it is a single measurement, though it has been directly AMS ^{14}C-dated to 3627–3365 cal BC (GrA-26922: 4680 ± 40 BP).

It has been previously suggested the circumscribed context of Orkney led to higher stocking rates on the limited good pasture, and the increased use of animal manure to maintain and increase crop yields (Schulting *et al.* 2010). We now have a large body of isotopic data on well-dated cattle remains from Skara Brae that provide some support for this hypothesis. Not only are the cattle bone collage values significantly enriched in ^{15}N compared to cattle in southern Britain (Budd *et al.* in press), but they show a similar tendency to increase over time as the human data from Quanterness, the Orcadian site providing the largest human isotopic dataset (Schulting *et al.* 2010). Thus, animal husbandry practices combined with higher rates of manuring of arable fields could account for the higher human δ^{15}N results from Scotland, without invoking the need for any dietary difference *per se*. A similar explanation might apply at Coldrum. In any case, this highlights some of the complexities and nuances of interpreting human isotopic data (Schulting 2015b), as well as the need for more ecological baseline data.

Region	*coast (within 10 km)*					*inland*				
	$\delta^{13}C$	±	$\delta^{15}N$	±	*n*	$\delta^{13}C$	±	$\delta^{15}N$	±	*n*
Scotland	-20.9	0.7	10.4	1.0	47	-21.5	–	7.7	–	1
England	-20.6	0.4	10.1	0.8	43	-20.9	0.4	9.5	0.8	172
Wales	-20.7	0.6	9.5	0.9	75	–	–	–	–	–
Ireland	-21.1	0.2	9.6	1.2	22	-21.8	0.5	11.0	0.6	17
Britain/Ireland	-20.8	0.6	9.2	0.8	187	-20.9	0.5	9.6	0.9	190
Sumburgh	-19.4	0.9	11.5	0.7	14	(includes M1 dentine values)				

Table 3. Average Neolithic human δ^{13}C and δ^{15}N values (± 1 SD) by region from coastal and inland sites. Sumburgh, Shetland, is excluded from Scotland and Britain/Ireland.

Discussion

Due to their insular setting, the process of Neolithisation in Britain and Ireland differs somewhat from the situation across Continental Europe. Many researchers, though not all (Thomas 2003; 2007; 2013), would now accept that a significant element of colonisation is implicated, though discussion continues over the details. Others find this debate too polemic, and seek alternative narratives (Cumming and Harris 2011; Garrow and Sturt 2011). It is hard to deny, however, that this is one of the fundamental questions to which we do want an answer. It surely matters whether we are dealing with a small number of influential individuals coming to Britain and Ireland with novel plants, animals and new ways of doing things, or whether there was a larger population movement that could be considered a true colonisation event or events. Continuing advances in isotopic studies of individual mobility and in ancient DNA research mean that such questions are not intractable. This is not to say that they can be answered at present, nor that isotopic and genetic data are themselves unproblematic or unassailable (Hofmann 2015; Milner *et al.* 2004). Rather, they can provide new lines of evidence to bring to the discussion. The importance of this is hard to overstate: witness the sea-change already brought about by ‘dietary’ stable carbon and nitrogen isotope analyses, lipid residue analyses of pottery and the application of Bayesian statistics to increasingly large radiocarbon datasets (Cramp *et al.*

2014; Richards and Schulting 2006; Richards *et al.* 2003; Schulting 2011; Shennan and Edinborough 2007; Whittle *et al.* 2011). And the first genomic sequence from a Neolithic individual from Ballynahatty, Co. Down, Ireland, has found clear evidence of Near Eastern ancestry (Cassidy *et al.* 2016). Moreover, the findings suggest that this individual was part of a population of large effective size. A major study is currently underway across Britain (http://www.nhm.ac.uk/our-science/our-work/origins-evolution-and-futures/human-adaptation-diet-disease.html), and will no doubt contribute much to the debate.

One of the objections to a significant impact from Continental migration to Britain in the process of neolithisation seems to have been that this somehow deprives the indigenous population from an active role in the process (cf. Bender 1978). There also seems to be an impression that imparting incoming farmers with agency deprives indigenous hunter-gatherers (Thomas 1988). 'Agency' cannot be lost in this way; there is not a limited amount to go around (though it can be downplayed analytically, and this is often the point being made). There may be imbalances in real or perceived power relations, curtailing the range of options available to agents in specific contexts, but this does not make them any less active participants in the choices made. But as archaeologists we are left with viewing the end result, and from even the medium-term perspective of a few generations (i.e., within community memory) it seems clear that in Britain and Ireland the transition to a committed farming way of life happened very quickly. Here at least, the term 'revolution' seems not inappropriate, encapsulated by Charles Tilley as 'rapid redefinitions between past and future, between shared memories and shared expectations...' (Tilley 1994: 247).

Conclusions

The comparison between southeast and northwest Europe brings into focus both similarities and contrasts. That there are many contrasts is not suprising, given the very different contexts involved, encompassing both geography (i.e., the insular position of Britain and Ireland more readily evokes a colonisation model) and culture-historical trajectories. The process of neolithisation also seems more variable in southeast Europe, perhaps seen most clearly in the well-studied Danube Gorges area, where there is evidence for a transitional phase – especially at Lepenski Vir – that seems distinctly lacking in Britian and Ireland. The concentration of Mesolithic populations in the Gorges, with its rich fisheries, may have placed indigenous communities and incoming individuals or groups (the distinction being an important one, concerning which we have as yet little information) on a more equal footing socioeconomically and demographically than was the case for some other parts of Europe, possibly including Britain and Ireland (Whittle 1978: 39).

Yet there are also similarities. Firstly, in both cases incomers are being increasingly implicated: through strontium isotope analysis in the Iron Gates, and through genetic studies in Ireland, though much more data are needed on both accounts. This situation calls even more strongly for an appreciation of cultural transmission theory (Vander Linden 2011). Secondly, the trajectory, though not smooth, is by and large a one-way process in both study areas, with no evidence for a return to a predominantly hunting and gathering way of life (with intriguing and seemingly short-term exceptions where farming may have failed, as at Sumburgh). Finally, while a mixed farming economy is the outcome, and this within a relatively restricted period of time – albeit more rapid in northwest Europe – there are nevertheless considerable variations on this theme in both study areas. This variation is seen both spatially and temporally, and in many ways this is becoming the more interesting question, or at least one that should be take as seriously as the initial process of neolithisation. Things did not remain static once the Neolithic appeared, and understanding subsequent changes are amoung the key challenges for the future (cf. Stevens and Fuller 2012; Whitehouse *et al.* 2014).

While the debate between the centrality of indigenous adoption and precocious incomers in understanding the transition to farming within specific regions is an important exercise, it is also useful to step back and take a broader perspective. This is the spirit in which we have presented this paper, providing some observations based largely on the human stable isotope data, as they relate to subsistence change in the process of neolithisation at the two extremes of Europe.

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Tables and Figures

Figure 1. Map showing locations of key sites mentioned in the text.

Figure 2. Plot of δ^{13}C and δ^{15}N values on Mesolithic and Early/Middle Neolithic human bone collagen from southeast Europe (n = 278) (sources: Table 1)

Figure 3. Plot of δ^{13}C and δ^{15}N values on Mesolithic and Early Neolithic human bone collagen from the Danube Gorges area (n = 211) (sources: Table 1)

Figure 4. Comparison between δ^{34}S and δ^{15}N values on the same individuals from the Danube Gorges area order by main chronological periods (n = 19). Source: Nehlich *et al.* 2010

Figure 5. Post-weaning human bone/dentine collagen δ^{13}C and δ^{15}N values from coastal/near-coastal Mesolithic (n = 31) and Neolithic (n = 187; Sumburgh n = 14) sites in Britain and Ireland (sources: Table 2)

Figure 6. Human bone/tooth collagen δ^{13}C values from British and Irish Neolithic coastal and near-coastal sites (within 10km of the modern coast or estuary) plotted against the average of the 95.4% range of the calibrated radiocarbon date (n = 203; sources: Table 2).

Figure 7. Human bone/tooth collagen δ^{13}C and δ^{15}N values from inland and coastal Neolithic sites in Ireland, Wales, England and Scotland (n = 377; sources: Table 2).

Figure 8. Average ± 2 standard errors for δ^{13}C and δ^{15}N values on human bone/tooth collagen from inland and coastal Neolithic sites (n = 377, excluding Sumburgh; sources: Table 2)

Table 1. Mesolithic and Early/Middle Neolithic human stable isotope values in Southeast Europe.

Table 2. Mesolithic and Early/Middle Neolithic human stable isotope values in Britain and Ireland.

Table 3. Average Neolithic human δ^{13}C and δ^{15}N values (± 1 SD) by region from coastal and inland sites. Sumburgh, Shetland, is excluded from Scotland and Britain/Ireland.