Archaeology

Sharp shift in diet at onset of Neolithic

The introduction of domesticated plants and animals into Britain during the Neolithic cultural period between 5,200 and 4,500 years ago is viewed either as a rapid event[1] or as a gradual process that lasted for more than a millennium[2]. Here we measure stable carbon isotopes present in bone to investigate the dietary habits of Britons over the Neolithic period and the preceding 3,800 years (the Mesolithic period). We find that there was a rapid and complete change from a marine- to a terrestrial-based diet among both coastal and inland dwellers at the onset of the Neolithic period, which coincided with the first appearance of domesticates. As well as arguing against a slow, gradual adoption of agriculture and animal husbandry by Mesolithic societies, our results indicate that the attraction of the new farming lifestyle must have been strong enough to persuade even coastal dwellers to abandon their successful fishing practices.

Stable carbon isotopes in human bone collagen act as indicators of past dietary intake[3] because marine and terrestrial dietary proteins leave different 'signatures'[4]. Consumption of cereal crops that use the C_3 photosynthetic pathway and of farmed animals should result in a 'terrestrial' bone-collagen carbon-isotope signature ($\delta^{13}C = -20 \pm 1‰$, where $\delta^{13}C$ represents the $^{13}C/^{12}C$ ratio), whereas marine foods give a much higher ^{13}C content ($\delta^{13}C = -12 \pm 1‰$).

Archaeological evidence for the use of marine foods during the British Mesolithic is limited because very few coastal sites survived the rising sea levels of the more recent Holocene epoch. Some of the best-known exceptions are the late Mesolithic shell middens of western Scotland[5,6]. Other areas of Atlantic Europe, most notably southern Scandinavia and Brittany, present strong archaeological and isotopic evidence of marine-based economies at this time.

We have measured and collated[6–8] the carbon-isotope values of bone collagen of 164 early Neolithic (5,200–4,500 yr BP) and 19 Mesolithic (9,000–5,200 yr BP) British humans. The Neolithic sample is derived from a range of contexts, including causewayed enclosures, chambered tombs, caves and stray finds, from both inland and coastal locations. Although individuals from inland and putative 'élite' contexts are more prominently represented, the results from all of these contexts are unanimous.

Figure 1 shows that, with few exceptions, individuals living near the coast in the Mesolithic show a moderate-to-strong marine isotope signal (for four humans from two inland sites, $\delta^{13}C = -19.6 \pm 0.8$; for fifteen humans from eight coastal sites, $\delta^{13}C = -16.2 \pm 2.8$), and that all of the Neolithic humans show a strongly terrestrial isotope signal (for 99 humans from 25 inland sites, $\delta^{13}C = -20.7 \pm 0.7$; for 68 humans from 19 coastal sites, $\delta^{13}C = -20.8 \pm 0.7$). These data are comparable with results obtained in Denmark, which also show a rapid dietary change in humans between the Mesolithic and Neolithic at about the same time[9,10].

From our findings, we conclude that there was a sudden and marked dietary shift associated with the onset of the Neolithic period in Britain, arguing against a gradual uptake of domesticated plants and animals into Mesolithic society[2]. Marine foods, for whatever reason, seem to have been comprehensively abandoned from the beginning of the Neolithic in Britain.

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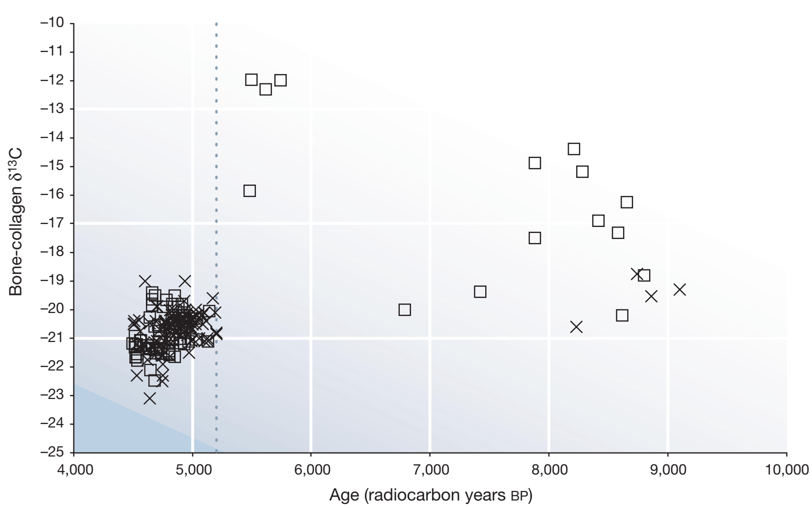

Figure 1 Bone-collagen carbon-isotope ratios and radiocarbon ages of 183 Mesolithic and Neolithic humans from coastal (that is, living within 10 km of contemporary coastline; squares) and inland sites (crosses) in Britain. There is a sharp change in the carbon-isotope ratio at around 5,200 yr BP (about 4,000 calendar yr BC; dotted line) from a diet consisting of marine foods to one dominated by terrestrial protein. This period coincides with the onset of the Neolithic period in Britain. Because of uncertainties in the size of the marine reservoir effect on radiocarbon dates, we have not attempted to calibrate the data here; however, for individuals with typical marine $\delta^{13}C$ values (about $-12‰$), radiocarbon dates should be corrected by roughly 400 radiocarbon years.

corrigendum

Insecticide resistance in mosquito vectors

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It has been drawn to our attention (I. Gould and P. A. Zimmerman) that the numbering of the amino-acid sequences and exon presented in our communication differs from that of the corresponding EMBL/GenBank entries. Because mosquito proteins differ in length, the first published acetylcholinesterase three-dimensional structure (from *Torpedo california*) was used to number structurally identical residues. The glycine residue whose substitution by serine confers insecticide insensitivity was therefore numbered 119, whereas it corresponds to amino acids 247 and 280 of *Culex pipiens* (entry CAD33707) and *Anopheles gambiae* (entry CAD56157) proteins, respectively. In *Anopheles*, this position lies within the third coding exon (exon 5). Our conclusions are not affected by this inconsistency.