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SAMPLE CREDENTIALS NECESSARY FOR MEANINGFUL HIGH-PRECISION ^{14}C DATING*

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ABSTRACT. Samples presented for high-precision ^{14}C dating must satisfy stringent requirements if the ^{14}C determinations are to yield meaningful sharp calendric dates, such as are now possible with the bidecadal high-precision calibration curve. The total carbon content should come from a confined time range 10–20 years (10–20 tree rings in wood or charcoal) appropriate for the bidecadal calibration curve. For accurate calendric dating the relation of these rings to the outer growth rings must be known. Application of the high-precision calibration curve to some archaeologic examples is discussed. It is now up to archaeologists and geoscientists to use this refined chronometric instrument to fullest advantage.

The Twelfth International Radiocarbon Conference was given the high-precision bidecadal tree-ring calibration curve of the ^{14}C time scale, with close agreement between the Seattle, Stuttgart (Douglas Fir or Sequoia and German Oak) and Belfast (Irish Oak) data extending back through 4500 years from AD 1950 (Stuiver & Pearson, 1986; Pearson & Stuiver, 1986). Data of Pearson *et al* (1986) go back to 7150 BP. This has provided an internationally acceptable absolute ^{14}C time scale back to 2500 BC. We should note here also how Suess' (1970) far-reaching observations have been set out with apparently global applicability, thus enabling long-range cultural comparisons to be confidently made.

It must be emphasized that this high-precision calibration data can only be meaningfully applied to ^{14}C estimations done on sample material which has appropriately stringent (and definitive) credentials, both of context and of characteristics of sample material. It must first be accepted that no accurate dating can be obtained from samples that have in themselves no intrinsic 'point' date, *ie,* they must have a known short life span (10–20yr) during which the carbon was part of the biosphere. No amount of statistical manipulation will yield calendric dates of meaningful accuracy out of data from samples (however numerous) that do not meet these requirements. This must apply, eg, to many powdered charcoal samples.

The fullest use of the calibration data can be made on sample material which has definable yearly growth increments, wood or well-preserved charcoal. This is of prime importance in the regions of complex inflections on the calibration curve, and Pearson *et al* (1986) have demonstrated how profitable the process of 'wiggle matching' can be in clarifying ambiguities.

Charcoal must be sorted analytically and fragments individually selected if it is to yield accurate calendar dates. Buildings are made mainly from mature timbers, from trees even 100 years old or more; if pieces of charcoal can be selected from the outer rings (towards the sapwood) we may be confident that we are coming near to the year of felling, and thus, to the years of construction. But miscellaneous charcoal samples gathered from a burned building can only give a broad date range. The rows of small

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holes which once held the withies of a partition (eg, young willow or hazel) can give valuable material, provided it is in sufficient quantity.

Domestic hearths need very selective treatment, for they may contain ancient carbonaceous material such as peat or even very old coal (Fig 1). Kilns usually yield batches of newly cut fuel and brushwood from the forest, especially in rural areas (Jope, 1953, 1956) and thus should be a useful source of short-lived carbon for dating.

Bone, in the form of its protein content, is coming increasingly into use for ^{14}C estimation, and bone of young or small animals could be a valuable source of material for high-precision dating.

The actual application of the high-precision calibration data to archaeologic problems must be appropriately tempered to the definable characteristics of each individual sample under investigation. For samples with an intrinsic ^{14}C origin time span of only 10–20 years, the bidecadal calibration curve is directly applicable. If, however, to accumulate sufficient sample material for dating, the sample has to be accepted from a longer time range, a calibration curve based on a longer interval must be used. The Conference agreed that publication of both the bidecadal and the 100-yr curves should sufficiently satisfy requirements. A 50-yr curve might also be useful, but can be constructed from the bidecadal curve data if needed. It must be emphasized that only when we can use the bidecadal curve with 10–20-yr samples are we really working with high-precision ^{14}C dating.

The examples discussed below deal only with the past 2500 years. There is still unease among some archaeologists about application of the calibration data to the more distant past, particularly to the 2nd–5th millennia BC. But with the full time range of these calibration data now available—over 7000 years—we are now clearly dealing with natural constants ascertainable by verifiable precision measurement, and such uncertainties

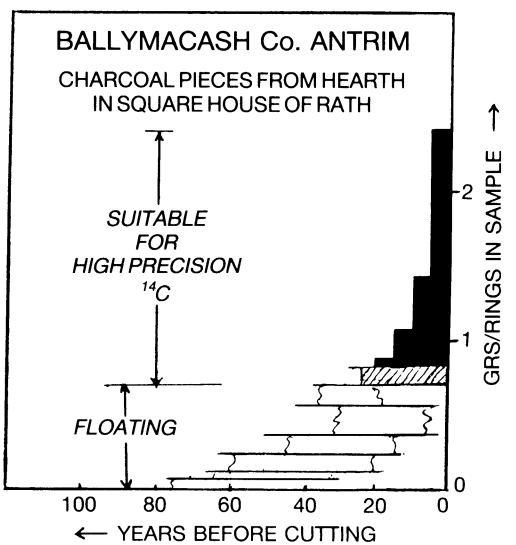

Fig 1. The rath at Ballymacash, County Antrim. Only pieces relating to the cutting date (*ie*, twig or small branch pieces preserved to the inner bark surface: solid black) are suitable. Most other pieces cannot be precisely located during the time of growth; thus, they are floating and are not suitable for accurate dating. The black represents the 0–5, 0–10, 0–15, and 0–20-yr pieces suitable for use with the bidecadal calibration curve; additional 0–25-yr material (shaded) could reasonably be added. In total this only yields ca 15g of charcoal. The area of black represents the weight of charcoal in the sample.

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must be expected to dissipate as sample credentials for earlier periods are defined with increasing precision.

It is now up to archaeologists and geo-scientists to design research to make the fullest use of high-precision ^{14}C estimation. Samples must be fully documented; excavators must plan for sample requirements (Simonsen, 1983; Kra, 1986).

A few examples of the application of high-precision ^{14}C procedures to archaeologic sites illustrate some of the problems involved, especially those related to documented events of later periods.

1) *Maiden Castle, Bickerton, Cheshire.* A hill-fort excavated by WJ Varley (1935, 1936); it has two wall defenses with horizontal timber lacing, usually characteristic of the early Iron Age in Britain (6th–4th centuries BC) but recently its *floruit* has been extended back into the later Bronze Age. Varley found massive oak timbers binding the dry stone walls. Recently, JJ Taylor, Liverpool University, did a supplementary excavation to obtain samples for high-precision ^{14}C estimation. A section of small scantling (ca 20 rings), apparently of alder, and a section of oak with rings towards the outer limit of the tree growth, were selected. The calibrated dates should yield estimates close to the time of cutting of these timbers. The dates are 405 ± 25 BC (Fig 2.2) and ca 422 ± 25 BC (Fig 2.3); the latter lies on an inflection in the calibration but is the more likely choice based on the result from the former, thus illustrating the great value of the high-precision curve.

The data from this Cheshire hill-fort make instructive comparison with data on charcoal samples from wall defenses of similar construction at Dinorben, Denbighshire (Savory, 1971; Cunliffe, 1974). The inflection ca 2400 BP shows that the Dinorben samples need not be so far apart in actual dates as a less precisely detailed curve would suggest: 400 and 415 rather than 520 BC; at any rate, later 5th rather than 6th century BC. These data begin to suggest the construction of strong hill-fort defenses in this northern part of the Welsh Marches during the years 420–400 BC.

2) *Ballymacash, near Lisburn, County Antrim, Northern Ireland.* A rath (small round enclosed farmstead) was excavated (Jope, 1986) and had a central square house of earth, turf, and timber, overlying an earlier occupation, and underlying a round house from a later occupation. A chunk of wood fragments (UB-2624) associated with Period II (the square house) gave a preliminary non-high-precision ^{14}C value of 905 ± 75 BP. Unluckily this lies right in the heart of the inflection complex in the calibration curve ca 900 BP, yielding a long date range of AD 1050–1160 (Fig 3).

It is most important to resolve this dating ambiguity, for we must be able to see such a farmstead in relation to changing rural economy in Ulster during the Anglo-Norman intrusion following AD 1172. Closer dating might have been possible by subdivision of the sample if it had been all from one timber. Well-stratified organic material was poorly preserved on the site, and much of the charcoal (eg, under the rampart) was powder mixed with mineral soil. This again stresses the urgent need for developing high-precision ^{14}C techniques using smaller samples (see Fig 1).

3) *Killyliss, County Tyrone.* Recent excavations on a rath (Ivens, 1984) also illustrates how preliminary examination of the available sample can

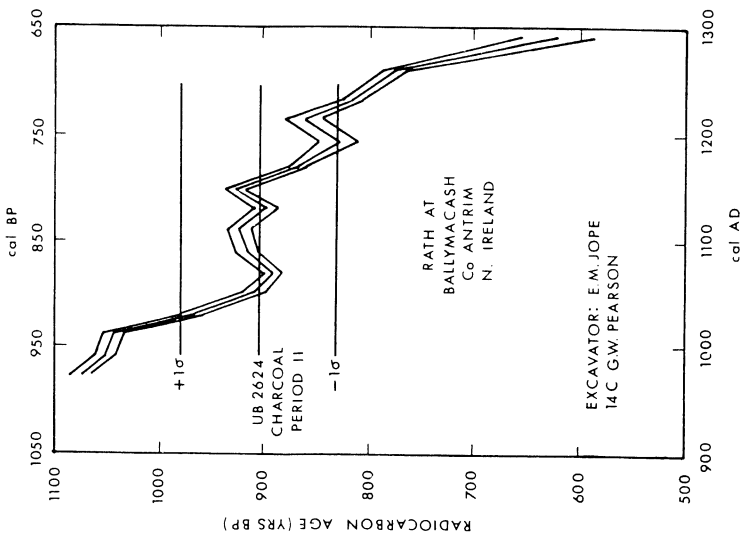

Fig 3. Rath at Ballymacash, near Lisburn, County Antrim, Northern Ireland. The sample was a knotty chunk from a hollow (perhaps a post emplacement), probably associated with the period of the square house (main occupation).

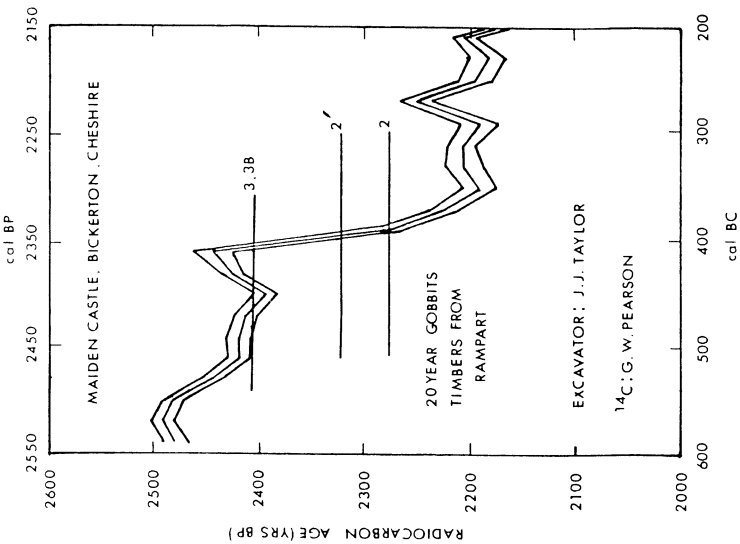

Fig 2. Maiden Castle, Bickerton, Cheshire. Iron Age hill-fort. High-precision dating (= ±16 yr) of timbers from horizontal lacing of defenses. The ^{14}C estimates are set against bidecadal calibration curve. 2,2′ represent duplicate runs (through the entire process) on a 20-yr growth ring piece of alder. 3,3B is on a 20-yr sample of oak timber.

provide valuable guidance for a meaningful high-precision study. The date, AD 595 ± 65, for material from the base of the ditch is significant in concluding that such raths were being built in west Ulster as early as the late 6th or early 7th century. The later development of the farmstead would be much clarified by more detailed mearsurements, especially in view of the unexpected discrepancy between the dendrochronologic and the ^{14}C estimates on later samples from the site (Baillie, 1984).

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