CORRESPONDENCE

Breton Tombs

SIR,—In "Breton Origin for Tombs" (*Nature*, **228**, 1019; 1970) several radiocarbon-14 dates are given in terms of absolute ages BC. I should hope your archaeological correspondent knows, and you should editorially recognize the fact, that radiocarbon-14 determinations do not produce results of this kind. Any determination is measured in years before present (BP, P being AD 1950) and has a standard deviation (for example, 5340± 250). The most accurate general usage of this should employ two standard deviations, that is, 4840–5840 BP or, if BC terms must be used, 2890–3890 BC.

Additionally, of course, radiocarbon years are not equivalent to calendar years, as recent tree-ring research is demonstrating. Renfrew[1] gives a useful review of this problem and its application to European prehistory in the period discussed by your correspondent, who seems to be somewhat behind the times (in publication years).

Yours faithfully,

J. PETER WHITE

Department of Anthropology,
University of California,
Berkeley 94720

[1] Renfrew C. A., *World Archaeology*, **2**, 199 (1970).

THIS letter has been shown to our correspondent, who replies:

Since the work of Stuiver and Suess in 1966 (*Radiocarbon*, **8**, 543), it has been clear that radiocarbon dates are only relative dates which require calibration. Despite the implied optimism of Mr White (and of Dr Renfrew), the accurate calibration of radiocarbon dates remains a task for the future. A more recent article by Renfrew which may not yet have reached Mr White is in the *Proceedings of the Prehistoric Society* (**36**, 280; 1970); there is an authoritative review by Suess in *Radiocarbon Variations and Absolute Chronology* (Proceedings of the Twelfth Nobel Symposium) (edit. by I. U. Olssen) (Wiley, 1970). When comparing dates *within* Europe, it remains most convenient to quote uncalibrated dates on the 5568 half-life. Whether these are expressed in years BP or BC makes not a fig of difference.

Certainly, the standard deviation of all dates should be considered (±2 σ giving about a 95% probability that the true age lies within the zone defined). The standard deviation relates only to counting error, however, and does not take into consideration other equally important potential error sources.

The essential point of my article was that the emerging pattern of radiocarbon dates for Breton passage graves sets them markedly earlier than elsewhere in Europe.

So far the Breton passage grave dates are 800 years and ten standard deviations earlier than any elsewhere. This difference and the merging pattern suggest the possibility of an independent origin of passage graves in Brittany. It remains perfectly possible, *pace* Mr White, that the earliest Neolithic settlers in England (earliest English Neolithic dates: 3390 BC±150 for Cissbury (BM-181) and 3505 BC±120 for Shippea Hill (Q-584)) were aware of Breton customs of collective burial and megalithic architecture.

Freezer Failure

SIR,—I wish to report the successive failure of no less than six ultra-low temperature electrical freezers from the same manufacturer. There are few calamities in a biological research laboratory worse than the thawing of such freezers in which are stored purified viruses, tissue culture cells, cell extracts, and purified enzymes. We have suffered considerable loss and inconvenience from these incidents, and wish to warn others of these problems.

The first of these freezers was installed in May 1969; it worked for only seven months. One compressor developed a short circuit, causing the contents of the freezer to thaw. After three months of attempting to fix the instrument (during which time we were of course severely hampered) the manufacturers determined that it could not readily be repaired. They loaned us a temporary replacement model, and agreed to provide us with a permanent replacement. The temporary freezer functioned for two months, then developed a leak in the refrigeration system and warmed up. Fortunately, by this time our permanent replacement had arrived, and was immediately connected in its place. This new freezer worked for three months, and then failed (apparently also due to a leak in the refrigeration system). The loss of several thousand dollars' worth of tumour viruses and enzyme preparations was narrowly averted because we were able to obtain some space in an older freezer which apparently had been functioning normally for several years. However, the automatic alarm system for power failure proved to be defective. This quasi-reliable instrument thawed when the power was inadvertently disconnected by maintenance personnel.

Two other freezers were installed in May 1970 in another laboratory of this department. One worked for one month, failed for several months, and is only now working properly. The other did not work when installed and was made operative only several months later. Their futures remain in continuous doubt.

Yours faithfully,

HARVEY F. LODISH

Massachusetts Institute of Technology,
77 Massachusetts Avenue,
Cambridge,
Massachusetts 02139

Obituary

Sir Christopher Ingold

SIR CHRISTOPHER INGOLD died on December 8, 1970, at the age of seventy-seven. The classifications, concepts and terminology which he introduced provided the framework for the theory of reaction mechanisms and influenced profoundly the development of chemistry as a whole.

Christopher Kelk Ingold was born in London on October 28, 1893. He chose to study chemistry, in spite of a characteristically strong interest in physics, and took his first degree at University College, Southampton. He went on to do research with J. F. Thorpe at Imperial College, leaving in 1918 to spend two years as a research chemist with Cassel Cyanide in Glasgow. He then returned to Imperial College in 1920 and four years later he was elected a Fellow of the Royal Society and appointed Professor of Organic Chemistry at the University of Leeds. He became Professor of Chemistry at University College, London, in 1930 and Director of Laboratories there in 1937. From 1939 to 1944 his department was in evacuation at Aberystwyth. As soon as the war ended he began re-establishing international links and quickly built up the department again, attracting research workers from all over the world. He was appointed Professor Emeritus on his retirement in 1961.

The contributions which Ingold made to chemistry were recognized by many honours and awards. The Chemical Society awarded him the Longstaff Medal (1951) and the Faraday Medal (1962). The American Chemical Society awarded him the James Flack Norris award (1965). The Royal Society awarded him the Davy Medal (1946)

and Royal Medal (1952). He received honorary degrees not only from a number of universities in the United Kingdom but also from universities in Eire, Canada, France, Italy and Norway. He was an Honorary Foreign Member of the American Academy of Arts and Sciences, the New York Academy of Science, the Weizmann Institute of Israel, Corresponding Member of the Royal Academy of Science of Spain and Foreign Academician of the Bologna Academy of Science. He was President of the Chemical Society from 1952 to 1954 and was knighted in 1958.

Ingold's contribution to chemistry was fundamental in the sense that a transformation in thinking arose from his work. His ideas on electronic structure of molecules and the ways in which bonds are broken and formed have become embodied in concepts and terminology which run not only through research work but also through the teaching of the subject. The developments in electronic theory came first. Recognizing the importance of polarization in determining equilibrium properties, Ingold related these to molecular constituents through the ideas of inductive and mesomeric effects. Developing the theory of chemical polarizability in parallel with that of polarization, he introduced the ideas of inductomeric and electromeric effects to account for electron displacements at the demand of a reagent. This extended the electronic theory of organic molecules to cover not only equilibrium properties but also chemical reactivity, and opened up the way to theories of reaction mechanism. He recognized that in mechanisms of chemical reactions a basic classification was provided by the distinction between two types of bond fission: homolytic and heterolytic. Following up the theory of electronic displacements in molecules he introduced the distinction between electrophilic and nucleophilic reagents according to their electronic demands.

In 1930 he was joined in the development of these ideas by E. D. Hughes and the two worked in close collaboration until Hughes's death in 1963. They introduced the concept of duality of mechanism, an important step forward because it provided a means of electronic classification that, together with earlier ones, formed the framework of a comprehensive theory of reaction mechanisms. In 1950, as Baker lecturer at Cornell University, Ingold began to bring together the developments which stemmed from these ideas and in 1953 he published his comprehensive *Structure and Mechanism in Organic Chemistry*. During his retirement he undertook the preparation of a second edition, expanding the original by some fifty per cent, bringing it up to date and completing it for publication in 1969.

From the middle 1930s onward, Ingold was also making important contributions in spectroscopy. His first work in this field was a pioneering study in the application of infrared and Raman spectra to isotopically labelled species in a detailed investigation of the benzene molecule. As a result of a second pioneering study he published an extensive set of papers on the properties of the benzene molecule in its first electronically excited state. Besides these studies, he investigated, in collaboration with G. W. King, the first excited state of acetylene, and established an important new principle, namely that electronic excitation may lead to a gross change in molecular geometry. His interests also took him into inorganic chemistry. In the early fifties he followed up ideas stemming from mechanistic studies in organic chemistry and extended these to a study of ligand replacement in metal complexes.

Ingold's knowledge of chemistry was vast and he had a remarkable insight into molecular behaviour. He combined these qualities with a powerful and critical mind which he could turn on almost any topic in chemistry. Whatever the subject of the weekly colloquia, which he rarely missed, he would unerringly go to the heart of the matter whether it concerned enzyme kinetics, spectroscopy, metal complexes or a variety of other topics. Incisively he would make his way to the centre of a problem and in a few terse sentences add illuminating comment. His breadth and depth of interest in chemistry led him naturally to build up an integrated department.

He was a courteous and kindly man, held in great affection by his students and those who worked with him. A mark of this affection was the publication in 1966 of a volume of tribute, *Studies in Chemical Structure and Reactivity*, edited by J. H. Ridd. A further mark of the affection and admiration in which he was held was the naming of the New Chemistry Building at University College after him at the official opening on September 25, 1970.

In 1924 he married Edith Hilda Usherwood who had already made important contributions to chemistry. He was the first to acknowledge how much he owed her, particularly for her support in his scientific work and in the administration of the department. He is survived by Hilda, their son Keith and two daughters.

Announcements

University News

Professor A. V. Crewe has been appointed dean of the Division of Physical Sciences, **University of Chicago,** in succession to **Professor A. Adrian Albert.**

Professor Glenn A. Berchtold has been appointed head of the Department of Chemistry at the **Massachusetts Institute of Technology,** in succession to **Professor John Ross.**

Dr Melvin Lewis has been appointed professor of clinical pediatrics and psychiatry at **Yale University.**

ERRATUM. In *Nature* for January 15 (**229**, 162; 1971), Mr William van Straubenzee, Parliamentary Under-Secretary of State at the Department of Education and Science, was wrongly reported to have used a form of words advocating the abolition of the means test now applicable to student grants. His real intention was simply to explore the case for and against a gap between school and university.

ERRATUM. In the article "New Interpretation of Extragalactic Radio Sources" by M. J. Rees (*Nature*, **229**, 312; 1971) the following corrections should be made: on page 313, for

$$1\left(-\frac{v}{c}\cos\theta\right)^{-1} \text{ read } \left(1-\frac{v}{c}\cos\theta\right)^{-1}$$

and for $\omega\left(\frac{\gamma}{f}\right)^{-1}$ read $\omega\left(\frac{\gamma}{f}\right)$;

on page 314, for $\left(\frac{4\pi n_2 e^2}{n_e}\right)^{\frac{1}{2}}$ read $\left(\frac{4\pi n_e e^2}{M_e}\right)^{\frac{1}{2}}$

and for $1-\left(\frac{(\omega_p')^2}{\omega^2}\right)^{\frac{1}{2}}$ read $\left[1-\frac{(\omega_p')^2}{\omega^2}\right]^{\frac{1}{2}}$

The requirement that waves continue to propagate outwards without dragging matter along is $\omega_p' \lesssim \omega$ not $\omega_p' \gtrsim \omega$; on page 315, line 17, for "therefore" read "thereafter". In equation (2) for $10^{4\cdot6}$ read 10^{46}, and for "infrared luminosity" read "inferred luminosity", in the second last paragraph of the same page.