50 & 100 YEARS AGO

50 YEARS AGO

In his first lecture, Prof. Medawar had emphasized the fallibility and limitations of our efforts to predict the future. Nevertheless, he maintained in his second lecture that it is not true to say that advances in medicine and hygiene must cause a genetical deterioration of mankind; there is more to be feared from a slow decline of human intelligence. But if that is happening, it is because the rather stupid are biologically fitter than those who are innately more intelligent, not because medicine is striving to raise the biological fitness of those people who might otherwise be hopelessly unfit ... Lord Adrian, too, emphasizes the need for much more information ... We have succeeded so well, he observes, in our aim at keeping alive every child that is born that we are certainly preserving many unfavourable genes which would otherwise have died out. "If we set out to save the unfit we must expect more unfitness in the world and more inheritance of the factors which promote it. Even if the radiation level remains as it now is, the advance of science can harm the genetic constitution of the race".

From *Nature* 13 February 1960.

100 YEARS AGO

It is now an evident fact that Paris has recently suffered the ravages of an inundation greater and more severe than any which have visited the city within the last two and a half centuries. A gauge at the bridge of La Tournelle shows the surface of the water as having reached a height above the bed of the river of 27 feet 10½ inches. Normally, it is only about 8 or 9 feet, and it is necessary to go back so far as the year 1658 in order to find any record exceeding, or even approaching, this figure. At that date the height attained was 28 feet 10½ inches ... The causes of the flood are not quite so obvious as the effects.

From *Nature* 10 February 1910.

metabolism and a likely predisposition (Fig. 1). They determined that their individual was an inbred male with a pattern of population-defining SNPs commonly found among east Siberians, and that he had an A+ blood group, brown eyes, non-white skin, thick dark hair and 'shovel-graded' front teeth typical of Asian and Native American populations. What's more, he had an increased susceptibility to baldness, dry earwax and a metabolism and body-mass index commonly found in those who live in cold climates.

With a growing number of SNPs being linked to morphological or physiological characteristics[9–11], we have an increasingly powerful forensic tool with which to 'reconstruct' extinct humans and the demographics of populations. This will also allow high-resolution analyses of worldwide population movements, on a scale not previously seen: future studies will probably be able to track movements more broadly across both space and time.

But it won't all be plain sailing. One big problem is that the majority of ancient human remains are found in temperate and even hot environments. Because the rate of degradation of ancient DNA increases exponentially with temperature, it remains to be seen whether genomic studies of hominin specimens from these regions will recover sufficient DNA to be informative. Whatever the case, Rasmussen and colleagues' findings[2] will no doubt stimulate a series of additional studies and provide useful methods for future investigations of human evolution. ■

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NUCLEAR PHYSICS

Weighing up the superheavies

Georg Bollen

To discover superheavy elements and study their properties, we need to know the masses of the isotopes of elements heavier than uranium. Weighing these isotopes in an electromagnetic trap has now become possible.

Nuclear reactions allow us to create elements beyond uranium (element 92), the heaviest element in nature. However, we are far from knowing what the heaviest possible element is. In the sparsely explored territory of superheavy elements, an 'island of stability' is expected. This island would consist of isotopes of elements that are more strongly bound and longer-lived than the isotopes surrounding it. Challenging expeditions towards the island have so far led to the discovery of elements up to element 118. But knowing the masses of the isotopes of elements heavier than uranium (trans-uranium elements) is of great importance for the success of the journey. In this issue (page 785), Block and colleagues[1] describe the first-ever direct measurement of the masses of isotopes of a trans-uranium element. They have used an ion trap as a high-precision scale for weighing isotopes of nobelium, an element that has ten more protons than uranium.

Chemical elements are sorted into a periodic table according to their properties. These properties reflect an atom's electronic structure, which is determined by the number of protons in the atomic nucleus. In a similar way, the approximately 3,000 known isotopes of the different elements are depicted in a proton number–neutron number diagram, the chart of nuclides. Most of these isotopes are radioactive and can be produced only artificially by using nuclear reactions. In exploring the limits to the existence of nuclides, physicists' expeditions have reached beyond uranium (92 protons) towards the northeast end of the chart of nuclides.

The existence of superheavy elements possessing many more protons than uranium was predicted four decades ago. Their increased stability against nuclear fission would originate from their nuclear shells being filled by protons and neutrons, like the electron orbits in an atom. For certain combinations of numbers of protons and neutrons — 'magic numbers' — a more strongly bound system would be formed that would also have a longer half-life. Accordingly, the superheavy elements are predicted to populate an island of stability located around proton number 120 and neutron number 184 (see Fig. 3 on page 787). Several exploratory groups have set sail[2–5] for this destination, and

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in the course of their journey have discovered various superheavy elements, the latest being ununoctium, with 118 protons. However, we cannot be certain that this is the heaviest element. And progress towards setting foot on the island of stability is slow because of the painfully low rates, sometimes only one atom per week, at which these exotic atoms can be produced.

The more difficult the synthesis of heavier elements and the production of their isotopes, the more important is the availability of better information on their properties, either through direct measurements or by better theoretical prediction. The accurate knowledge of masses is particularly critical. Einstein's mass–energy equivalence relates the mass of an isotope directly to how strongly its protons and neutrons are bound; that in turn determines whether it can exist and its lifetime before it decays. This is where Block and colleagues[1] have achieved a breakthrough — by performing the first direct mass measurement on the isotopes of a trans-uranium element and by providing the information needed to build a bridge to the island of stability. Furthermore, they have demonstrated that the technique chosen is indeed the most promising one for meeting the challenge of determining the masses of isotopes of superheavy elements.

Block *et al.* determined the masses of the isotopes ^{252}No, ^{253}No and ^{254}No of nobelium. The result achieved for ^{253}No led to a tenfold improvement in the accuracy of its mass, and as a consequence, to an improved knowledge of the masses of all isotopes in the α-decay chain of which it is a member. An α-decay chain is a sequence of radioactive decays in which elements transform into one another by emitting an α-particle. The measurements were performed with SHIPTRAP, a facility specifically developed for high-precision experiments using trapped ions of very heavy and superheavy elements.

For the mass determination, powerful Penning-trap mass spectrometry[6] was used. In a Penning trap, charged particles can be confined and stored in a strong magnetic field under vacuum for long periods of time. The frequency of the circular, 'cyclotron' motion performed by a trapped ion is connected to its charge, its mass and the magnetic-field strength. By determining this frequency, it is possible to obtain the ion's mass. Such mass measurements can reach extremely high precision — relative uncertainties of less than one part in a billion have been achieved for stable ions[7]. The real challenge in applying this approach to superheavy elements is reaching a high enough efficiency in transferring these rare isotopes as ions into the trap. Here[1], SHIPTRAP has set a new record for the lowest production rate for which a Penning trap has been successfully used to measure the mass of an unstable isotope.

Until now, superheavy elements were identified by their indirect connection by α-decay chains to known elements around uranium. Penning-trap mass measurements can tie down loose decay chains that are not yet connected to known elements. Block and colleagues' first direct mass measurements provide firm anchor points that are much closer to the superheavy elements than before, in addition to improving the accuracy of the mass values for all isotopes in these chains. And such Penning-trap mass measurements[1] may become even more important in the long term. As the island of stability is approached, the lifetime of the nuclides is expected to become longer with the addition of more neutrons. Theory predicts half-lives as long as minutes to hours, a trend that is supported by experiments. For half-lives this long, the identification of superheavy elements on the basis of the radioactive decay of their isotopes will no longer be feasible. Identifying new superheavies by weighing them in a Penning trap may then be the only practical approach. ■

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PALAEONTOLOGY

Decay distorts ancestry

Derek E. G. Briggs

Experiments with simple chordate animals show how decay may make the resulting fossils seem less evolved. The consequence is to distort evidence of the evolution of the earliest vertebrates and their precursors.

Just as human corpses become more difficult to identify as information is lost through decay, so too do the fossils of our marine ancestors from back in the Cambrian. For example, a remarkable diversity of soft-bodied, fish-like fossils, dating to about 525 million years ago, have been described from Chengjiang in China. Uncertainties about the nature of these creatures, however, have fuelled controversies about their place in the early evolution of chordates, the group that includes all vertebrates and some closely related invertebrates.

On page 797 of this issue, Sansom and colleagues[1] describe laboratory observations of the decay of two living forms similar to these earliest chordates: the lancelet *Branchiostoma* (a fish-like invertebrate that has a stiffened structure called the notochord) and the larva of the more familiar lamprey. They find that decomposition of these two creatures always occurs in more or less the same sequence. Features of the head, for example, tend to be

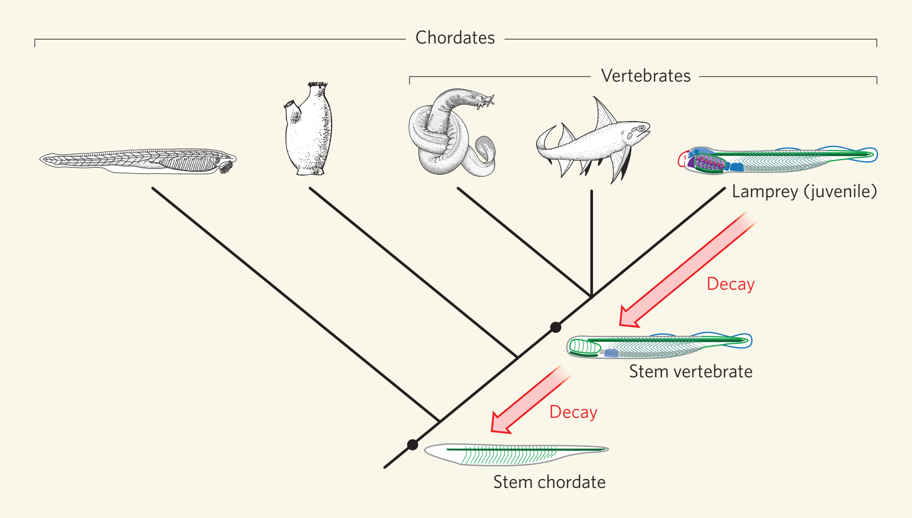

Figure 1 | 'Stem-ward slippage.' Decomposition and the loss of morphological features have the effect of making a fossil seem less evolved than the organism was in life, and therefore closer to an ancestral (stem) position on an evolutionary tree. This simplified version of the chordate tree shows (left to right) outlines of representatives of the cephalochordates and urochordates, and three branches of the vertebrate lineage. Sansom and colleagues' decay experiments[1] with juvenile lampreys show that the progressive loss of features would lead to interpretation of the resultant fossil as a stem vertebrate and then a stem chordate. (Figure based on Fig. 3 of ref. 1.)

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