**Palaeomolecular biology**

**Raising the dead and buried**

from Alex J. Jeffreys

Is the quagga as dead as a dodo? Not entirely, and nor indeed might be the dodo, if the remarkable findings of Russell Higuchi, Allan Wilson and co-workers reported on page 282 of this issue are anything to go by. Because even though the quagga, a curious chimaera of horse and zebra, became extinct just over a century ago, some of its DNA has survived in a museum specimen in a state suitable for molecular cloning.

As a start, Higuchi et al. managed to isolate partially degraded DNA from dried quagga tissue and to show that at least some of it is of quagga origin, rather than a contaminant, by virtue of its hybridization with DNA from the closely related zebra.

More importantly, it was possible to obtain clones of specific mitochondrial DNA sequences. Comparison of these sequences with those of zebra mitochondrial DNA provided the final proof that they are of quagga origin. Not only are the two species' sequences as closely matched as is expected for congeneric animals but most or all of the differences that do exist (mainly synonymous base transitions at third codon positions) are clearly not due to postmortem changes in DNA that have been subsequently misrepairred during cloning, and so they must reflect the evolutionary history of the quagga. Clearly, the great power of molecular phylogenetic analysis, so far restricted to living animals, can now be brought to bear on at least some extinct species.

The choice of mitochondrial DNA was wise in view of its abundance: there are many mitochondria in each cell. However, to extrapolate from Higuchi et al., it might even be possible to extend such studies to single copy genes of the nucleus. Thus 3 gsn of preserved tissue should yield sufficient DNA to produce a library of up to 3 x 10^7 clones, each containing perhaps 100 base pairs of quagga DNA and together covering most of the genome.

The obvious next question is whether other museum specimens will yield up their molecular secrets. One can only hope that museum curators will be reasonably sympathetic to hordes of molecular biologists eager to dismantle their cherished exhibits. Anthropologists could benefit too — DNA sequences of bog people and Egyptian mummies would no doubt be fascinating, though cloning the latter might prove too nerve-racking a task for the superstitious genetic engineer.

A century or two in a museum is one thing; 40,000 years in a Siberian permafrost bog — the fate of the Magadan mammoth — is another. Nevertheless, Wilson's group (Fed. Proc. 43, 1557; 1984), M. Goodman's (Acta Zool. Femica, in the press) and my own (unpublished) have shown that substantial quantities of DNA can be recovered from preserved mammoth tissue. Unfortunately, almost all of it comes from recent microbial contamination, probably introduced after excavation. Elephant-like DNA sequences are present at vanishingly low levels (less than 1% in 10^10 of the total DNA) and are severely degraded. Cloning this DNA would indeed be a mammoth task, and any sequence information recovered would probably be seriously distorted by postmortem modification. We know nothing about the chemistry of DNA degradation over geological time periods.

Any hopes that molecular biology and palaeontology can be fused into a grand evolutionary synthesis by studying fossil DNA, still look like nothing more than a glorious dream. However, it is far too early to give up, and it might just be possible that DNA has survived in some fossilized material.

One final point: DNA can easily be purified from animals that have died, and once dried it is stable and should survive for centuries without degradation. It is therefore vital that zoos or museums should start systematically to store DNA from as many species as possible, and certainly from any that face extinction. Friedrich Miescher, who discovered nucleic acid in 1868 (see Vogel, F.C.W. *Die histochemischen und physiologischen Arbeiten von F. Miescher, Leipzig, 1897*), could have saved Higuchi et al. a lot of trouble if he had had the foresight to make and store fresh quagga 'nuclein'.

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**Particle accelerators**

**New concepts for high energies**

from J.D. Lawson

SPECTACULAR development of particle accelerators has sustained the progress of elementary particle physics during the last half century. Although current projects, and others yet to be funded, will ensure the progress of particle physics until the end of the century, there is serious concern about what will happen beyond then. We need some new concepts or some radically new technology to continue past trends. Two years ago high energy and accelerator physicists met in Oxford to consider 'The Challenge of Ultra-High Energies'. A few weeks ago they met again, this time in Frascati, to examine in more depth some of the ideas discussed at Oxford.

The 'colliding beam' concept, first demonstrated twenty years ago, becomes particularly effective when the ratio of total particle energy to rest energy, becomes large. Almost the total energy of 2ym^2, is then available for particle creation and excitation, whereas if one of the particles is initially stationary in a target, it

A quagga mare exhibited at London Zoo from 1851 to 1872. The photograph was taken 13 years before the death of the last captive quagga in Amsterdam in 1833. (Zoological Society of London.)
NEWS AND VIEWS

100 years ago

THE NEW VOLCANIC ISLAND OFF ICELAND

At the end of July this year the light-keeper at Cape Reykjanes, the south-west point of Iceland, reported that a volcanic island had risen in the sea a few miles off the cape. Reykjanes has long been noted as a centre of volcanic activity, and from time to time islands have arisen and submarine eruptions have occurred in its neighbourhood. In the year of the great Skaptarfjall eruption, which proved so fatal to Iceland, 1783, an island appeared off Reykjanes, only to disappear again after a very brief existence. Only a year or two ago an eruption of considerable violence occurred in the sea, not far from the spot where the new island appeared. Columns of steam and clouds of dust, mingled with occasional glowing masses of fused rock, had been seen to rise out of the sea, and large quantities of pumice were thrown up and drifted ashore on the neighbouring coast.

When first seen, on July 29, its shape was that of a truncated cone with a slight depression on the top, and a considerable hollow half way down the slope on the north side. On August 5 and 6 a series of violent earthquake shocks occurred, which shook and split the masonry of the lighthouse and damaged the lamps. The island's shape was considerably altered: a large part of the slope on the south side had slipped down into the sea, where it now lies, forming two little hillocks close to the foot of the main mass, and leaving a steep face nearly perpendicular towards the bottom.

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NATURE VOL.112 13 NOVEMBER 1904

NATURE rings per machine, In also represents Accelerator method, and specification attempting worthwhile Rubbia bunches each mined beam power is rare ineffic. porver supplied energy. in involving affordable bunches formulae yields (Cornell University) is who indicated extrapolation fields are also than acceptable cost better than: (SLAC). An emphasis that optical sub-micron particles for 100 MeV/metre should be possible by development of conventional techniques; this implies not more than 50 km for a 5 TeV machine, a large but not incredible value. Any new approach must either enable such fields to be obtained more economically than at present or promise higher fields.

Progress was reported on two other linear accelerator concepts, the 'wake' accelerator by T. Tajima and T. Weiland (DESY) and the 'two beam' concept of A. Sessler (Lawrence Berkeley Laboratory). In the former, converging wake fields from a ring of electrons moving through a suitable structure produce intense fields on the axis which can then be used for acceleration. Experiments to test the idea are underway at DESY in Hamburg, FRG and, with a different geometry, at Osaka in Japan. In the two beam accelerator power is provided not by an array of klystrons, but from a single low energy electron beam that runs parallel to the accelerator structure. This passes alternately through magnetic undulators, which generate the required microwave power by free electron laser action, and induction sections that restore the beam energy. An experiment at Livermore has produced 100 MW of radiation at 34 GHz with 5 per cent efficiency. Both these ideas aim at high fields, but their potential still needs to be established.

As at the previous meeting, the 'beam-wave' concept of T. Tajima (University of Texas) and J. Dawson (University of California, Los Angeles), excited considerable interest. It promises the most spectacular accelerating fields, generated by beating together two laser beams in a plasma, where the difference of the laser frequencies is equal to the plasma frequency. Despite tantalizing figures for the field gradient, the detailed physics of the process is still not clear and it is too early to see how one might design such an accelerator. In the United States, experiments are planned to try setting up and detecting a beat wave, and there are hopes that an experiment will be approved in the United Kingdom. There is plenty of scope for further theory and simulations, and for ideas on how to use the concept to build an accelerator. The stringent requirements for efficiency and good beam quality make this task difficult, but there was plenty of enthusiasm for further exploratory work.

An idea much discussed in earlier meetings is the acceleration of particles over a grating carrying an evanescent surface wave, excited by an incident laser beam. At its simplest this would not be efficient, but basic experimental studies on the coupling of waves and grating structures are being planned in Ottawa. A development due to R. Palmer (Brookhaven) is to replace the grating by two rows of tiny spheres spaced about three to a wavelength. The idea is to squirt these from an ink jet printer and, when they have arrived at the correct position, to subject them sequentially to a travelling pulse of laser light. This should render the spheres conducting and, on the short time scale required, capable of sustaining the enormous fields required for rapid acceleration to high energies of a beam of injected particles. The spheres act as a sort of receiving antenna that transfers energy from the laser light to the particles. Everyone will have their own views about how credible these new concepts really are, but there was considerable enthusiasm at the meeting and no doubt that the future is going to bring increasing activity in this fascinating and potentially important field.