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On Entering the Small World of Elements, Molecules and Micromorphology

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Introduction

The closer I get to the next and more ancient phase of my life, the more I get interested in mummification. But my experience of various kinds of mummies over the years instills in me considerable pessimism about my achieving a good state of preservation for the next world. I confess that I don't fancy being soaked in natron and rubbed with resins or camel fat as preservative procedures – or being disembowelled for that matter. Plastination? I prefer not. Freeze drying should be the ideal for us all now, if costing is ignored – but colleagues in conservation laboratories still seem uncertain about the stability of internal organs in the freeze drying of whole bodies. Clearly there is experimental work to be done here.

Considering that Thomas Pettigrew wrote his classic work on mummies one hundred and seventy years ago (Pettigrew, 1834), we might have expected numerous academic volumes to follow, but they remain scarce, so that the papers from these congresses provide a much needed opportunity for work in this field to become more accessible. In my student days, one of my heroes was Sir Grafton Elliot Smith, whose work on the Egyptian Royal Mummies, as well as hundreds of ordinary inhumations, set high standards for early in the 1900's. Only much later did I learn that his ego was far bigger than his kindness and consideration to younger colleagues. But this congress, I'm sure, like the previous ones, will be a stimulating egalitarian affair, and I look forward to hearing the papers. Turin provides an ideal setting for such a meeting – a beautiful old city and fine Egyptological collections. Our President, Emma Rabino Massa and her colleagues have been concerned to apply biological techniques to the investigation of ancient human remains, and in this short presentation I would like to broadly reflect on the current state of progress, as I see it, on some laboratory techniques and studies of ancient remains. Papers at congress will no doubt update what I now say.

Radiographic aspects

Since early mummies and bones were crudely X-rayed over a century ago, the application of new equipment and techniques offers considerable potential, especially in the elaboration of small detail. A few months ago I was able to see the new Canon digital radiographic unit in action, and in difficult circumstances. Our concern at the time was with three mummies deep in a side chamber in the Valley of the Kings. The digital unit enabled us to operate the active radiographic component separated from the rest, and there was instant viewing, with the capacity to immediately enlarge or measure small sections of the images.

Of equal potential, but in a different way, is the micro-CT scan, some results of which Professor Rethy Chhem of Canada demonstrated to me very recently. This will clearly make the detailed scanning of diminutive specimens, including small animal mummies, so much easier in the future. My current interest in its potential is to explore defective tooth morphology and dental tissue anomalies in early guinea pigs, considered to be caused by hypovitaminosis C, which might have occurred with early domestication. Surprisingly, the micromorphological information to be derived from scanning electron microscopy has not been as forthcoming as I'd anticipated in a 1969 article (Brothwell, 1969). In particular, and this is from my point of view, I would be interested to see more identifications of food debris trapped in dental calculus, especially if mummified remains also permitted the analysis of semi-digested food from the intestinal tract. The two kinds of information from one body might not be the same, but together might provide more balanced evidence of the diet of the individual.

DNA analysis

Would I be correct in stating that it is in the broad field of applied chemistry, that most effort and progress has been made? Ancient DNA jumps to mind, and with the elaboration of the PCR technique, a whole new world appeared. I confess to being naïve and believing its potential was greater than it may well be. Taphonomic factors and contamination are still serious problems, and sadly it looks

as if bodies and bones from warmer climates or acid bog conditions are not ideal for DNA survival. This is an area where further controlled experimental taphonomic work would be valuable.
In the case of microbial DNA, progress is also very slow, although satisfactory evidence of at least mycobacterial DNA appears to have been securely made. What is especially pleasing is that other techniques and analyses have now appeared and could run parallel to the DNA work, as confirmatory techniques. For instance, the identification of mycolic acid residues as an indicator of tuberculosis could potentially even replace aspects of mycobacterial DNA work. Similarly, the pioneering work which has identified microbial antigens indicating schistosomiasis, may well herald a new era of palaeoimmunology.
Tests for the identification of other diseases is in progress, and indeed it is many years since the Wassermann reaction was tested – and alas failed – on bone pathology considered to be treponemal. Malaria and Yersinia plague have similarly received attention with varying degrees of success. And any consideration of malaria takes us back to the important question of balanced polymorphisms and the identification of ancient abnormal haemoglobins. At present both normal and an abnormal haemoglobin have been identified in ancient remains, but we now need population studies, perhaps especially on better preserved Egyptian and Nubian samples.

The applications of chemistry

And in talking of haemoglobin variation we move to perhaps one of the most important research fields for the future – that of applied chemistry. Gone are the days of very basic inorganic analysis of materials, although inorganic elements can still be highly informative. They could be used for instance to attempt to identify the homeland of a mummy currently curated in Spain, but whose origin is the Philippines or Peru. Isotopes of oxygen or strontium, which can assist in geographic identity, may give the answer, and such an investigation is currently underway. Obviously, DNA may assist, as well as possible embalming characteristics and any intestinal food remains indicating specific regional foods.
The combination of gas chromatographic and mass spectrophotometric techniques provides a powerful analytical tool for the detection of embalming treatments, whether by resins, waxes or even by smoking. There is also the question of body paints and tattoos, and there can be residues even when the epidermis is missing. The constant improvement in instrumentation is also enabling the greater detection and analysis of proteins, especially those with unique sequences. My colleague Matthew Collins has a special interest in this field, and has initiated research on the potential markers of scurvy in bone proteins. This could be extremely valuable in confirming sub-clinical scurvy in ancient humans, which I feel we are overlooking. Not only under siege conditions and in ancient voyagers such as the Vikings could vitamin C deficiency have occurred, but even groups from which our well preserved bodies are derived could at times have been at risk. The men of the Scythian tombs of Siberia must have seen little in the way of vitamin C during the long winter months, as indeed appears to be the case in the Mongolian nomads even today.

Data banking

This acceleration in the production of masses of scientific records gives me, I confess, growing cause for concern. In fact the international organization and storage of both materials and data needs urgent attention. The University of Manchester has led the way in its creation of a tissue bank, but there is a need for at least one in the Americas, as well as perhaps specialist collections – for instance of hair. With the advent of digitized radiographs would it be possible to have a reference centre for such information also? And is anyone archiving the growing amount of information on the DNA of ancient bodies? Should we, as a congress, begin to take these problems in hand and discuss them further? And how long term and safe is the information currently being stored on discs, in a variety of formats, in all too many places? Academics are good at research and data collection, but I'm far from convinced that we are good at banking this information accessibly for colleagues and for the future.

The problem of teaching

The papers in this conference clearly indicate the increasing range of scientific studies related to ancient bodies, and the contributions are made by a range of specialists. There is nothing wrong with that, except that no academic department seems to fully accept responsibility for teaching this interdisciplinary field in its entirety – either at an undergraduate or postgraduate level. In the last few decades, 'medical anthropology' and 'forensic anthropology' have both taken shape and have become established university courses. I'm not suggesting that the next step is the creation of 'mummy anthropology', but that such studies find a more visible place in courses on Holocene human remains, and have the right breadth of detail – from body anatomy to body chemistry and pathology. Perhaps this should also be a talking point over coffee at this congress or a future one.

Animal mummies

One final point. Emma Rabino Massa has wisely invited contributions on non-human mummies. Studies on these other species have certainly been neglected, yet most of the investigations undertaken on humans are equally possible on other species. The range of potential information includes embalming chemistry, fake mummies, information on domestication status, demographic factors

and pathology. Eggs have, in some cases, become mock-ups of bird mummies. A sick baboon, possibly suffering from nutritional hyperparathyroidism, was mummified as if normal and healthy. X-rays of young crocodiles show they were embalmed at specific sizes, possibly in relation to rearing practices and the size of tanks they were kept in. Were the vast number of ibis mummies all wild birds or could they have been semi-domesticated? There is clearly a separate crop of questions which can be aimed at these non-human specimens.

Conclusions

What I have tried to say in this brief preamble to the main business of the congress, is that considerable scientific progress is being made in the study of well preserved human and non-human remains, with new technology and analytical methods still appearing on the scene. We now need to consider this field of research by various levels of publication, by curation – both of tissue and data – and by bringing this work more and more into university course work.

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