Molecular science is revolutionising archaeology — researchers can now tell what Mesolithic man had for

There's still life in these old bones...

Bone meal: archaeologists can identify ancient diets by analysing the isotopes of carbon from samples of human bone

Hear the word "archaeology" and what comes to mind? People digging shallow trenches in faraway countries or methodically reconstructing fragments of pottery and stone? Increasingly, this is only part of the picture. During recent decades, laboratory science has begun to play a major role in the work of archaeologists, allowing them to pursue once-impossible lines of inquiry.

The idea of using science to explore the past is nothing new. Take, for example, the chemist Alfred Lucas, who was among the members of Howard Carter's team when he found the tomb of Tutankhamun. But his techniques — reliant on large samples and using "wet" chemistry in test tubes — were unsophisticated. Laboratory science began to make more of an impact in the 1950s, after the invention of radiocarbon dating, which won Willard Libby the Nobel prize in 1960. This ushered in a new era of archaeological science, says Martin Jones of the University of Cambridge. Now carbon dating has become routine. More recently, as holder of the Pitt-Rivers chair of archaeological science, Jones has witnessed the latest phase of this evolution: the advent of molecular archaeology.

The molecules in question are large and mostly of living origin. Prince among them is DNA, the material that carries the hereditary information in our genes. The first archaeological use of DNA was in the early 1980s. DNA analysis is now used not just on human material but also on plants and animals. It can reconstruct patterns of migration, unravel the history of agriculture, illuminate the spread of diseases and even help work out the family trees of extinct creatures.

Jones works on the bimolecular archaeology of early crops. "I'm interested in the origins of agriculture, and whether it was a historical event; whether it was the result of a single community inventing a new idea that then spread, or a slower and more dispersed evolution." With crops, these alternatives would be reflected in two possible types of family tree. In the first, the tree would spread from a single tight trunk; in the second, it would be more dispersed in space and time.

At Bradford University, archaeologist Carl Heron has studied the large Egyptian jars, or amphorae, employed 3,000 years ago in the late Bronze Age to transport oils and resins, often used as incense, from the coast of what is now Lebanon. These jars, manufactured in Palestine, were used for carrying bulk commodities in vessels plying trade routes around the Eastern Mediterranean and along the coast of North Africa. Analysing and identifying deposits of the organic materials remaining on the inner surfaces of amphorae allows Heron and his fellow archaeologists to fathom patterns of trade, and so understand local economies and much else about the people of the times.

"Our analytical techniques are by their nature destructive," Heron says. "So part of our challenge is to develop and use micro-sampling methods that leave some of the material for future analysis." The quantities of such material remaining on these bits of pottery are often vanishingly small. But access to techniques such as mass spectroscopy make it possible to work with sample sizes of the order of nanograms.

Research at Bradford has recently cast light on an issue that archaeologists have been debating for years: the speed with which the advent of domesticated plants and animals changed our ancestors' lives. In Britain, the switch from hunting and gathering to farming took place during part of the Neolithic period between 5,200 and 4,500 years ago. But was its impact on diet immediate or did it happen over many generations, or even many hundreds of years?

Bradford's Michael Richards, with colleagues from Queen's University Belfast and

VINTAGE BREWS GET THE MIDAS TOUCH

A vintage wine is a perfect blend of past and present, **writes Patrick E. McGovern**, but what if we take the process a step further and recreate ancient wines in a modern-day setting?

After analysing the intense yellowish residues inside 8th-century BC bronze vessels, deposited in what is believed to be the tomb of "King Midas" or one of his forebears in central Turkey, I became interested in trying to recreate their contents — biomarkers in the residues, including tartaric acid from grapes, suggested a drink combining wine, beer and mead.

At a beer-tasting event at the University of Pennsylvania Museum, I asked microbrewers whether they could produce a historically accurate (and drinkable) rendition of the beverage.

The permutations were endless. Were the wine, beer and mead made separately and then mixed together? Within two months, we were testing brews. The winning microbrewer opted for a single brew including yellow muscat grapes, since it has been shown by DNA analysis to be related to the earliest cultivated grapes in the Middle East. The grapes were added late in the brewing process at a lower temperature to give a fresh, natural aroma. The bittering agent was yellow saffron, for which Turkey was renowned in antiquity.

The final result, sold as Midas Touch, was a golden-hued drink with reddish highlights — a combination of beer, wine and mead, with a layered muscat aroma and a saffron taste that drew you back for more.

There has been much speculation about how humans first discovered wine. The main problem for the biomolecular archaeologist is that organic containers have not been preserved from the Palaeolithic period (500,000 — 10,000BC). Moreover, without adequate preservation, the wine would have a restricted production schedule. Therefore, winemaking on any large scale could have begun only in the Neolithic period (about 8500-4000BC) where the necessary preconditions — permanent settlements, an assured food supply, a variety of food-processing techniques — came together.

The university museum was an excellent place to begin looking for chemical evidence of Neolithic wine. Our first breakthrough came in 1996 from the Neolithic village of Hajji Firuz Tepe in the northern Zagros Mountains of Iran. Using infrared spectrometry, liquid chromatography, specific spot tests and gas chromatography-mass spectrometry, we showed that at least two jars in a suite of six, dated c.5400-5000BC, contained a wine laced with terebinth tree resin. Analyses of other areas followed. Almost without exception, a tree resin had been used — the winemakers were making retsina, as it is known in Greece today, the only country that perpetuates the tradition. Without any knowledge of bacteriology, the ancient winemaker apparently observed that tree resins might serve as a "medicine" for stopping wine turning to vinegar. They added aromas to the wine. Resin from the terebinth tree was preferred, so much so that Pliny the Elder, the 1st century AD Roman encyclopaedist, calls it the "queen of resins".

BRIDGEMAN

Fit for a king: analysis of residue on vessels deposited in the tomb of 'Midas' suggested a mix of beer, mead and wine

Neolithic winemaking was probably born somewhere in the upland regions of the Taurus, Caucasus or Zagros Mountains, where the wild Eurasian grapevine thrives. During this period special winemaking equipment, storage containers and drinking sets start to appear in the archaeological record, implying that a "wine culture" was taking shape and it began to fan out across the region, becoming a major focus of social interactions, religious ceremonies, art and literature, pharmacopoeias, cuisines and economies.

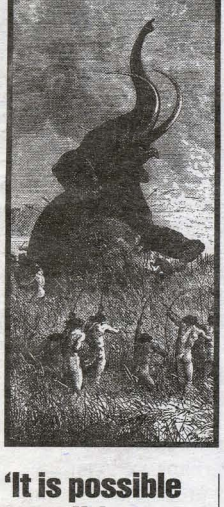
Near Eastern kings were largely responsible for the spread of wine culture. They celebrated victories with wine-drinking ceremonies and stocked their tombs with the elixir. They also offered wine to the gods. Their conspicuous consumption and gifts of wine and

lunch. **Geoff Watts** investigates

Oxford University, has investigated ancient diets by analysing the isotopes of carbon from samples of human bone going back through the Neolithic period, into the Mesolithic. Different foodstuffs contain different amounts of two of carbon's stable isotopes. This is deposited in the bones of those who eat these foods. Because the isotopes remain unchanged over the years, their ratio acts as a kind of "signature" of an individual's diet. In this way, it is possible to tell from even the oldest bone fragments whether someone's food was derived predominantly from the land or the sea.

By excavating tombs and digging around in middens — some inland, others near the coast — Richards and his colleagues unearthed 164 Neolithic and 19 Mesolithic bone fragments. With few exceptions, they report, Mesolithic people living near the coast had a diet rich in seafood. "But after 4000BC in Britain," Richards says, "none of the people we measured had any marine foods in their diets. It seemed like this was a big and rapid change. Even people on the coast didn't go on eating marine foods."

MARY EVANS



'It is possible to tell from even the oldest bone fragments whether someone's food was derived predominantly from the land or the sea'

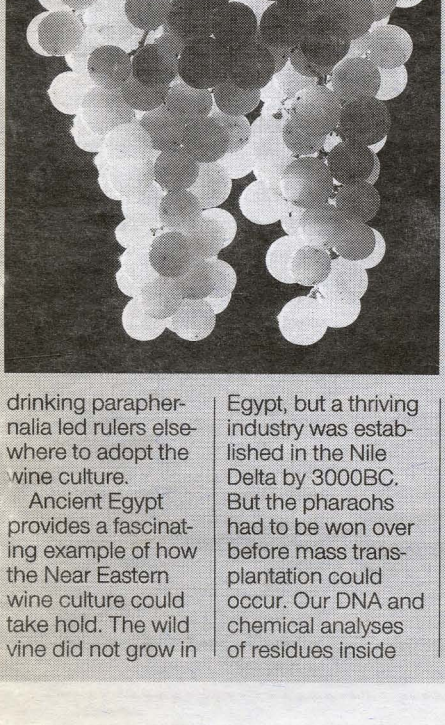
Why did the products of the new agriculture prove so instantly attractive? "I wish I knew," Richards admits. "One idea is that people wanted to have more reliable food supplies. If you grow it yourself, you know how much is there." Another possibility is that its appeal was associated with much wider cultural change. Could this have been the earliest sign of our now ubiquitous preoccupation with fashion? Richards does not deny the possibility.

As Jones recalls, when he began work, the most sophisticated measuring device around was a tape measure. Nowadays, archaeologists can use global positioning satellites. And many artefacts hold far more secrets than can be gleaned by the closest scrutiny. "Something like 40 to 50 per cent of pieces of pottery have chemical traces of what went on inside them. I suspect that sooner rather than later we'll see chemical analysis become a routine part of archaeology."

Access to new techniques is changing the way that archaeologists work — but does it also alter the way they think? Jones says it shapes different questions. "You can ask questions that never seemed relevant before. With a cemetery, it's now possible to ask not only who was related to whom, but whether males were fitter or more hard working or better fed than females."

Who said that dead men tell no tales?

CEPHAS



jars found at the tomb of Scorpion I showed that the jars had been made in the southern Levant, where wine-making had been flourishing for a millennium. DNA analysis is narrowing in on when and where the Eurasian grapevine was first domesticated. More exacting chemical analyses should shed light on the minutiae of ancient winemaking.

drinking paraphernalia led rulers elsewhere to adopt the wine culture.

Ancient Egypt provides a fascinating example of how the Near Eastern wine culture could take hold. The wild vine did not grow in Egypt, but a thriving industry was established in the Nile Delta by 3000BC. But the pharaohs had to be won over before mass transplantation could occur. Our DNA and chemical analyses of residues inside

Patrick E. McGovern is adjunct associate professor of anthropology, University of Pennsylvania. His book *Ancient Wine: The Search for the Origins of Viniculture* is published this week by Princeton University Press, £18.00.