PHOTO: B Gramsch, Potsdam

Neolithic foodies

ABOVE The presence of a prehistoric site at Friesack was originally revealed during early 20th century bog drainage. Since then, excavations have recovered over 150,000 artefacts, most of which date to the Mesolithic. Among the finds were some fragments of Neolithic pottery, which have gone unwashed for about 6,000 years.

How we know that caviar was on the menu 6,500 years ago

Science holds the promise of revealing long-lost prehistoric recipes from food residues encrusted on pots. One early discovery from Germany is that caviar was being served up during the Neolithic period. **James Romero** takes us behind the scenes of a process that looks set to bring a new flavour to the past.

Burnt food crust stuck to the bottom of a lazily washed 6,000-year-old clay pot has been claimed as the earliest evidence of caviar being prepared and eaten by ancient people. The sherds in question were recovered from a prehistoric site known as Friesack 4 in Brandenburg, Germany. Early 20th century drainage of bogs beside the River Rhin first revealed the presence of archaeological material at the site. Since then, several investigations have been launched, establishing that Friesack 4 served as a major seasonal camp for Mesolithic hunter-gatherers, before attracting a settled population at the beginning of the Neolithic period. All told, the site has produced over 150,000 artefacts, most of them Mesolithic. These objects range from decorated turtle shells to birch bark resin 'chewing gum', but it is the caviar residues on fragments of Neolithic pottery that provided the biggest surprise.

The discovery of the decadent dish is the latest demonstration of the archaeological potential of a modern protein analysis technique more commonly used for drug targeting, and even – controversially – used to attempt to extract proteins from dinosaur fossils. While proteomics – or the analysis of proteins – is a well-established

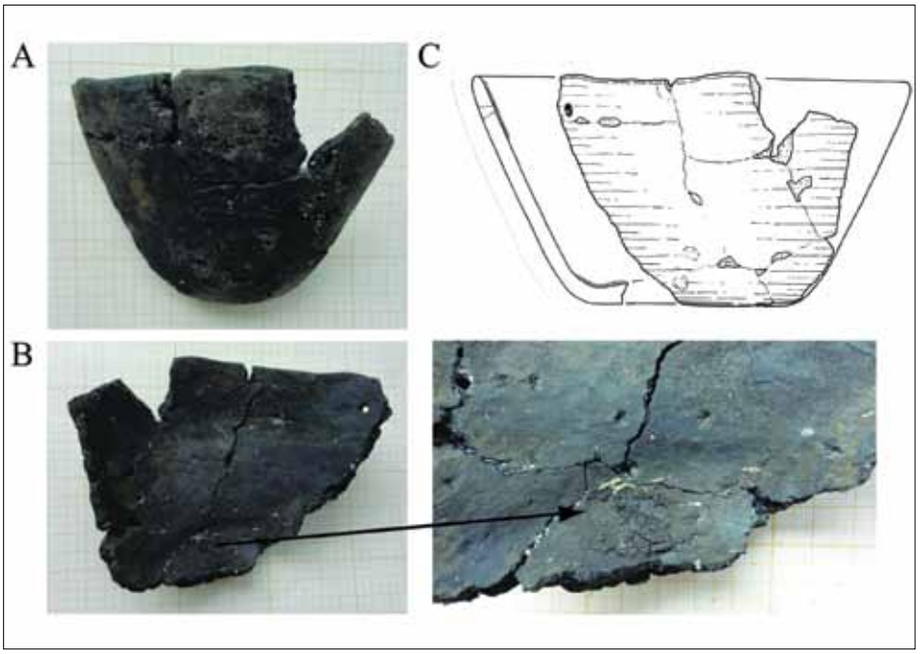


PHOTO: G Wetzel

field in biology, it has only fairly recently been successfully applied to archaeology thanks to developments in mass spectrometry that can now detect small amounts of protein. As different types of protein are unique to different plants and animals, or indeed different parts of the same plant or animal, this allows for the identification of the organism used to make organic objects, the food or bacteria preserved in dental plaque, or, in this case, the food residue left behind in pots or other containers.

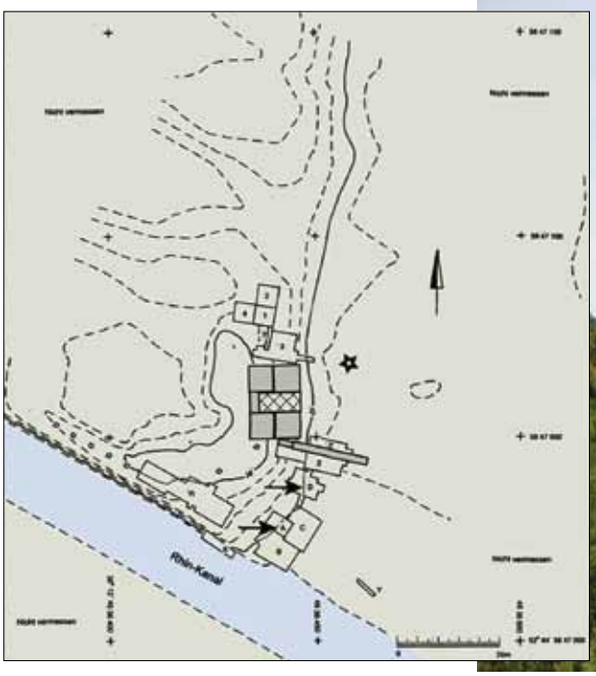
This ability to capture not just what ingredients were present in ancient leftovers but how they were processed – whether the dish was cooked, for instance – holds the promise of unlocking far more than just prehistoric diets. As the researchers responsible for detecting the use of caviar, Anna Shevchenko, Andrea Schuhmann, Henrik Thomas, and Günter Wetzel, put it in the paper discussing their results: 'identification of protein composition in foodcrusts might also assist in reconstruction of cooking recipe of prehistorical foods' (see further reading on p.XX). Could we be on the brink of rediscovering a wealth of long-lost prehistoric dishes?

Caviar culture

As well as revealing a taste for this modern signature of culinary sophistication, the research paints a broader picture of paleodiets in the region between the Elbe and Oder rivers, and the role of aquatic resources in these ancient economies.

'It is interesting that ancient people almost 6,000 years ago, who led such comparatively primitive lives in a harsh environment, were a sort of foodies', says lead author Anna Shevchenko from the Max Planck Institute of Molecular Cell Biology and Genetics in Dresden, who ▸

BELOW Excavations underway at Friesack 4. This seasonal Mesolithic camp and later Neolithic settlement lay beside the River Rhin. The plan (inset) notes the locations of the various archaeological campaigns conducted at the site. M. Schneider dug in the shaded area (1916–1928); the filled grey areas were excavated by H. Reinerth (1940); those designated with 'W' were explored by S. Wenzel (2000–2001); areas annotated 1-4, 7, A-D, X-Z ere investigated by B. Gramsch (1977–1989; 1998). The position of the 1979 test trench where the fragments of the small pot with the organic residue dating to c. 4300 – 4000 BC is indicated with an asterisk.



IMAGES: B Hildebrand and D Becker

LEFT & BELOW Getting creative: Neolithic people were eating to enjoy food, not just to survive. Experimental archaeologist Jacqui Wood from Saveock Water Archaeology, has recreated some of their methods and meals, including this cooked fish dish (left).

PHOTOS: Jacqui Wood, Saveock Water Archaeology

presented the research at the ASMS Conference on Mass Spectroscopy. 'It is wrong to think they had a pure eating-for-surviving strategy. They were obviously also eating to enjoy food and were creative in food preparation.'

Mesolithic inland sites in Europe are often situated close to rivers or lakeshores, so it has long been suspected that fish and water plants formed part of their diet. Archaeological evidence to test this one way or another is often in short supply, though. While objects that were likely used to catch or process such foodstuffs are found, fish bones and scales are poorly preserved in acidic soils and sometimes not directly targeted by archaeological recovery strategies. Societies where pottery was widely used offer an alternative way of seeing what was being eaten, as food smears are sometimes still encrusted on cooking pots.

Such residues were found on a range of pot fragments from Friesack 4, which were selected by Günter's team. The size and shape of these pots varied, but in most cases they were large and probably used for cooking or stewing whilst set on open fire or embers. There was also a smaller cooking bowl among the collection, which appears to have been a valued household utensil, as a tiny hole near the rim looks like an attempt to mend the vessel after it was damaged. If so, the pot was destined to be damaged once more, as it broke into 12 pieces during excavation. Radiocarbon dating of the organic crusts on these sherds places them between c. 4300 and 4000 BC. While this gives an indication of when the meal in this pot was served up, establishing what was on the menu presents a challenge for traditional techniques. Standard isotope techniques, which rely on fatty or oily biomolecules called lipids that are often preserved in food stains and crusts, cannot identify particular species of meat or fish, or types of vegetable. Results can also be highly affected by abundant modern environmental contaminants such as soil bacteria.

That is where matters would probably have rested for the Friesack 4 material, if serendipity had not introduced Günter to the work of Anna and her colleagues. He was sitting on a train reading the German national newspaper Der Spiegel, when a particularly quirky article caught his attention. Shevchenko and her lab featured in a report describing the recovery of 3600-year-old cheese from an ancient Chinese mummy. This success was one of the first notable applications of proteomics to make sense of messy organic archaeological samples. 'The advantage of proteomics is that old traces can be distinguished from more recent ones, and thus mistakes can be avoided', says Günter. 'The method has great potential. It can provide important data not only about paleodiet and its impact on health, but also shed light on the burden created by diseases, as well revealing genetic alteration in the past, and much more.'

Günter appreciated the relevance of this technique to the Friesack 4 finds, and by 2014 his samples had arrived at Shevchenko's lab in Dresden, so that the clues lodged in the crusts could be teased out. One important consideration for the technique is the need to extract a sufficiently large sample for analysis. Through logical thinking Anna was able to predict where the food crust might be best preserved and secured sufficient residue. As you would expect for such an old sample, proteomics analysis identified a wide variety of proteins from the food samples, including those linked to human, microbial, plant, insect, terrestrial animals, and fish sources. The ability to filter out more modern traces revealed that only the two fish proteins – vitellogenin and parvalbumin – were specific to the food crusts. Using a sequence similarity searching tool, Anna matched them to sequences from the common carp. Vitellogenin is a major protein in fish egg yolk, thus one of ingredients of the meal was seemingly carp roe, more commonly known as caviar.

Seasonal cuisine

Fish roe or caviar is an ingredient of many traditional recipes. It is considered a delicacy and can be consumed, grilled, fried, marinated, baked, smoked, dried, cured, and also boiled in broth. The fish meal enjoyed at Friesack is more suggestive of an exquisite seasonal dish than a staple food. After separation from inedible offal, the roe appears to have

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been cooked for immediate consumption, possibly poached on embers in small volumes of water or fish broth. During cooking, the small pot was probably capped with leaves, the charred remains of which can be seen on electron microscopy images. The fish itself may well have been preserved and consumed later.

The analysis was completed in 2015. Such was the team's surprise at what they found – especially when it came from a technique that was still in its archaeological infancy - Anna's team wanted to convince themselves that the results were robust, and only shared them in 2018. 'I didn't believe it when I saw it', recalls Anna. 'I turned to my assistant and said you have done a bad job, adding "I'm sorry but you must have put some contamination in." I was joking of course!'

Verification included performing the same protein analysis technique on fresh carp roe. Anna sent her assistant to the Heinz Mueck fish farm in Dresden, not far from her institute, to buy a big carp. They then removed the roe (the remainder was gifted to her mother-in-law for dinner that week) and analyzed it using proteomics. Their caution proved unfounded, though, as this additional analysis only confirmed the accuracy of the original findings.

PHOTO: James Dilley, www.ancientcraft.co.uk

Despite the results gleaned from the Friesack pots, the Chinese mummy cheese, and several other studies, there are hurdles to overcome in terms of proteomics wider archaeological adoption. Günter stresses that the success or failure of the analysis is largely decided at the excavation stage. 'More attention has to be paid to treatment of artifacts during excavation, particularly to the protection of their purity', he says, pointing to the damage that can be caused by smoking, excessive handling, delays before packing, and a lack of washing to remove soil contaminants. 'We archaeologists have to learn more about these new methods to avoid the situation where their broader application fails on the archaeological side.'

ABOVE What's cooking? Neolithic food preparation as part of a living history experience, complete with replica pots to be washed.
BELOW The common carp: one of the members of the carp family in the frame for the source of the roe cooked up at Friesack 4.

Anna wants to encourages archaeologists to consider proteomics analysis. 'Bring us samples', she says. 'Analyse whatever ancient organic material you have. It is full of surprises. My personal dream is to analyse Egyptian bread. I would like to know how Egyptians prepared their bread and I hope to get a sample for proteomics one day.' Günter agrees about the potential for major new information. 'In combination with lipid analyzes and scanning electron micrographs, a lot of new discoveries are likely to be made in the future, especially for the transition from hunter-gatherer to farmer-cattle-holder behaviour.' It seems that over the coming years we all have cause to be grateful that prehistoric peoples did not wash their pots more diligently. ◘

FURTHER READING

A Shevchenko, A Schuhmann, H Thomas, and G Wetzel (2018) 'Fine Endmesolithic fish caviar meal discovered by proteomics in foodcrusts from archaeological site Friesack 4 (Brandenburg, Germany)', PloS ONE https://doi.org/10.1371/journal.pone.0206483