Neolithic potsherd (pottery fragment) by Dane Comerford
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The London Mathematical Society

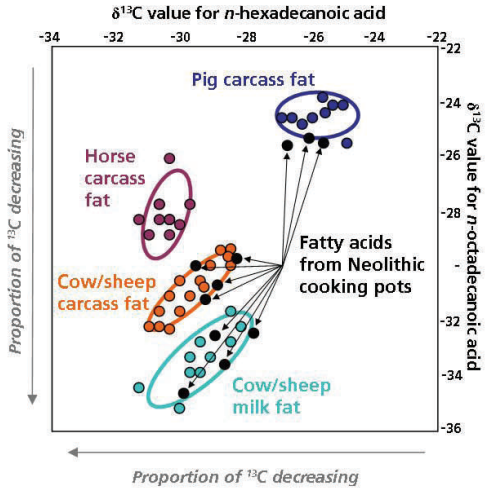
The Institute of Mathematics and its Applications

The Palaeodetectives

how ratios help identify what's cooking

A great deal can be learned about how people lived in the past from organic residues preserved in ancient cooking pots. The Palaeodetectives recognise the processing of animal products from the presence of fat molecules. To work out which part of the animal it came from, they use the simple concept of ratios. Ratios are a way of comparing two quantities, expressed as X:Y. By looking at the proportions of two stable carbon isotopes in a fat sample, the team create a molecular and isotopic 'fingerprint' on what they call the $\delta^{13}C$ values of the fatty acids that make up the fat.

$$\delta^{13}C = \frac{(^{13}C : ^{12}C)_{sample} - (^{13}C : ^{12}C)_{standard}}{(^{13}C : ^{12}C)_{standard}} \times 1000$$



The $\delta^{13}C$ values are determined from the proportion of ^{13}C, the heavy isotope of carbon (containing 6 protons and 7 neutrons in its nucleus) to the lighter isotope ^{12}C (containing one less neutron). They use an isotope-ratio mass spectrometer, comparing the proportion to an international standard.

The graph shows how the $\delta^{13}C$ values for *n*-hexadecanoic acid and *n*-octadecanoic acid for different animal fats reflect their source. By comparing the $\delta^{13}C$ values of the molecules of the fat preserved in ancient cooking pots with those of modern animals, the Palaeodetectives can work out where the animal fats came from—for example, whether it was milk or carcass fat.

The team use many other mathematical techniques, from statistics to organise their data to mixing equations (part of fluid dynamics) to probe the composition of mixtures. These enabled them to help police with a murder enquiry and with fraud detection in the vegetable oil trade.

Ratio *X:Y* *Proportion* *Statistics* *Mixing Equations* *Fluid Dynamics*