the gradient between the sea water (2 °C) and the hot (350 °C) toxic hydrothermal fluid is so extreme that spatial measurements need to be accurate to the centimetre. Unlike the other prominent members of these communities, such as vestimentiferan tube worms and brachyuran crabs, experimental study of the alvinellids is impossible as they rarely reach the surface alive. One of the most challenging issues is that of the temperature range that the two *Alvinella* species are able to withstand. Previous preliminary temperature measurements[6] revealed the temperature range within a colony to be dramatic: 20 °C at the tube openings, 100 °C 10 cm into the colony, and more than 250 °C 10 cm deeper. Although it was unclear exactly where the worms reside in the colony structure, later observations have reported individuals living around 50 °C (ref. 7).

Our most recent results, obtained in October 1991 and April 1992 during the joint French–US HERO (Hydrothermal Environment Research Observatory) expeditions at 13° N on the East Pacific Rise, are based on discrete temperature measurements made with the probes of the submersibles *Nautile* and *Alvin*, and were simultaneously recorded on video film. Nine measurements made on the animals' branchial funnels (at the opening of the tubes) were in the range of 20–45 °C. Six measurements were then made 2–3 cm inside tubes, four of these are 40–50 °C and the other two 70–80 °C. The most astonishing observation was a dislodged live *Alvinella pompejana* that, for a few minutes, coiled around the tip of *Alvin*'s high-temperature probe, which simultaneously recorded 105 °C. The worm then returned to the chimney surface, displaying a behaviour similar to that of other worms when out of their tubes. It has been previously reported that *A. pompejana* could withstand high temperatures, but this is the first time that such an observation has been recorded on video (see figure).

This extreme temperature clearly exceeds the physiological optimum suggested for *Alvinella* species (20–50 °C) by biochemical criteria (haemoglobin O_2 affinity[8], malate dehydrogenase kinetics[9], collagen melting temperatures[10] and mitochondrial respiration[11]). However, our observations raise the question of the upper temperature limit of these organisms, perhaps the highest known for invertebrates and possibly eukaryotes.

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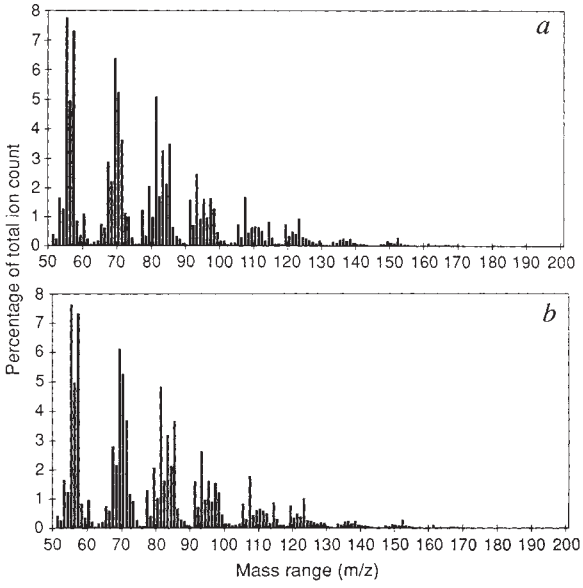
1. Wehner, R. *et al. Nature* **357**, 586–587 (1992).
2. Heurtault, J. & Vannier, G. *Acta Zool. Fennica* **190**, 165–171 (1990).
3. Brock, T. D. *Thermophilic Microorganisms and Life at High Temperatures* (Springer, New York, 1978).
4. Hinton, H. E. *Nature* **188**, 336–337 (1960).
5. Carlisle, D. B. *Science* **161**, 279–280 (1968).
6. Desbruyères, D. *et al. C.r. hebd. Séanc. Acad. Sci., Paris* **295**, 489–494 (1982).
7. Baross, J. A. & Deming, J. W. *Bull. biol. Soc. Wash.* **6**, 355–371 (1985).
8. Toulmond, A. *et al. Biol. Bull.* **179**, 366–373 (1990).
9. Dahlhoff, E. & Somero, G. N. *J. exp. Biol.* **159**, 473–487 (1991).
10. Gaill, F. *et al. J. molec. Biol.* **221**, 209–223 (1991).
11. Dahlhoff, E. *et al. Physiol. Zool.* **64**, 1490–1508 (1991).

Neural networks and olive oil

SIR — Virgin olive oil is the oil extracted by purely mechanical means from sound, ripe fruits of the olive tree (*Olea europea* L.). Such oils with a free fatty acid content (in terms of oleic acid) below 1% are termed 'extra virgin', whereas those with good flavour but greater acidity may be graded as 'fine' or 'semi-fine'. Lower grades, including those that have been subjected to refining, are called 'lampante' or 'pure'. Olive oil is considered to contribute significantly to the nutritional and health benefits of Mediterranean-type diets and, uniquely among vegetable oils, the flavour of olive oil is best enjoyed without refining. Olive oil therefore commands a higher price than other vegetable oils, and these and other properties mean that there is a great temptation to adulterate olive oils with other seed oils[1]. Although various methods have been proposed for the detection of olive oil adulteration[1], none has found widespread usage. We wish to report here that a combination of Curie-point pyrolysis mass spectrometry (PyMS)[2,3] with multivariable data analysis using artificial neural networks[4] has permitted us to effect a rapid assessment of the adulteration of extra virgin olive oils with various seeds oils.



Pyrolysis mass spectra of a virgin olive oil (*a*) adulterated with 5% soya oil (*b*).

Two sets of samples were prepared in G.B.'s laboratory, each consisting of 12 samples of various extra-virgin olive oils plus 12 samples variously adulterated with 5–50% of soya, sunflower, peanut, corn or rectified olive oils. The experiment was performed double-blind, such that the identities of the second set were not known to any of us. PyMS was performed at 530 °C using a Horizon Instruments PyMS-200X machine[3]; two typical spectra are shown in the figure, where it is clear that their distinction by eye is difficult.

We trained an artificial neural network consisting of an input layer of the 150 normalized ion intensities with mass: charge in the range 51–200 and one hidden layer of eight nodes, using the standard back-propagation algorithm[4] as implemented in the NeuralDesk package (Neural Computer Sciences, Totton, Southampton), coding virgin oils as 1, non-virgins as 0. When the network had trained (r.m.s. error < 0.001), we tested it on the unknowns. When the code was broken, it transpired that the network had correctly assessed each oil. In a typical run, the virgins were assessed with a code of 0.99976 ± 0.000146 (range 0.99954 – 1.00016) and the non-virgins with a code of 0.001079 ± 0.002838 (range 0.00026 – 0.01009). We conclude that the combination of Curie-point PyMS and artificial neural networks constitutes a powerful approach to the assessment of food adulteration.

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1. Kiritsakis, A. & Marakakis, P. in *Essential Oils and Waxes* eds. Linskens, H. F. & Jackson, J. F. 1–20 (Springer, Heidelberg, 1991).
2. Meuzelaar, H. L. C., Haverkamp J. & Hileman F. D. *Pyrolysis mass spectrometry of Recent and Fossil Biomaterials* (Elsevier, Amsterdam, 1982).
3. Aries, R. E., Gutteridge, C. S. & Ottley, T. W. *J. analyt. Appl. Pyrol.* **9**, 81–98 (1986).
4. Rumelhart, D. E. *et al. Parallel Distributed Processing.* (MIT, Cambridge, 1986).