news and views

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tells the tell-tale signs of what something was,
particular fossil is so indelibly etched with

in the fossil record, provides independent evidence and fresh ideas with which to
describe the mechanistic basis of hominin evolution.

We can hope that this study represents 
the vanguard of a new wave of analyses that
focus on the genetic basis of human evolu-
you hypothesize about human origins 
must take into account our understanding of
the hominin fossil record. But it is studies such as these that will put meat on the bones
of any theory. With the impending com-
pletion of the project to sequence the
chimpanzee genome, the tantalizing prospect
of whole-genome comparisons between humans and our closest living relatives is not
enough far away. It has been suggested that such a comparison could throw up around 40
million nucleotide differences between humans and chimpanzees. Identifying
which of these differences encode the essen-
tial elements of being human is a daunting
task. Sophisticated comparative genomic
and expression-profile analyses have none-
theless already been completed, revealing
patterns in gene evolution and expression
that may guide us to functionally important
differences. More than any other report
before it, however, the study by Stedman et al.
suggests that the genetic basis of human
evolution can and will be defined.

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Sydney 2010, Australia.

How do you look so good?

Roger J. Davey

Crystallized brown sugar is quite miraculous: it takes just a few ‘seeds’ in the crystallization process to trigger the formation of many times more crystals. Now we are starting to understand why.

The generation of a solid from a solution through crystallization might sound such a simple, familiar process that one could be forgiven for thinking that it is fully understood. But despite the work of Wilhelm Ostwald on crystal nucleation, and the development of classical nucleation theory, this is not so. Take an everyday example such as brown sugar, millions of tonnes of which are crystallized annually, to be dis-
solved in tea and coffee. The crystals are all of uniform size — no really big ones, no really small ones — and all are nicely faceted (Fig. 1). This is no accident: the effect is achieved by a process known as ‘seeding’, in which small crystals of pulverized sugar are intro-
duced in the solution to act as seeds on which crystal growth can start. This seeding, how-
ever, does not follow the rules of the garden,
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seeds are hollow spherical sections, varying
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ture and size of seeds, both spherical and
cylindrical, affect nucleation. When the seeds are hollow spherical sections, varying in radius from 10 to 150 times the diameter of the crystallizing colloidal particles, it seems that nucleation is easier on the convex side of a seed’s surface than on its concave side. For cylindrical seeds, it is easier still. This ‘experiment’ reveals what looks like a ‘nucleus factory’, centred on a seed particle
(see Fig. 4 on page 405), which allows the final number of crystals to be larger than the number of seeds.

Experimentally, the question and appli-
cation of seeding may go back to Louis Pasteur’s discovery in the mid-nineteenth
century of optical activity in crystals of sodium ammonium tartrate. The compound’s optical activity is due to its chirality, the fact

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seedling process might work, choosing the case where the seed is a foreign substance
rather than a crystal of the solute (as it might be in, for instance, the seeding of clouds to induce rain).

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How come you look so good?

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The generation of a solid from a solution through crystallization might sound such a simple, familiar process that one could be forgiven for thinking that it is fully understood. But despite the work of Wilhelm Ostwald on crystal nucleation, and the development of classical nucleation theory, this is not so. Take an everyday example such as brown sugar, millions of tonnes of which are crystallized annually, to be dissolved in tea and coffee. The crystals are all of uniform size — no really big ones, no really small ones — and all are nicely faceted (Fig. 1). This is no accident: the effect is achieved by a process known as ‘seeding’, in which small crystals of pulverized sugar are introduced in the solution to act as seeds on which crystal growth can start. This seeding, however, does not follow the rules of the garden, with one new plant (or in this case, crystal) per seed. In fact, the amount of seed needed to catalyse the whole crystallization may be less than 1% of the mass of the final product. How do so few seeds give rise to so many crystal nuclei?

We do not really know for sure, and so I am intrigued by the work of Cacciuto and colleagues3, reported on page 404 of this issue. Through computer simulations, Cacciuto et al. have investigated just how a

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Experimentally, the question and application of seeding may go back to Louis Pasteur’s discovery in the mid-nineteenth century of optical activity in crystals of sodium ammonium tartrate. The compound’s optical activity is due to its chirality, the fact
that it can exist in two forms, or enantiomers, that are non-superimposable mirror images of each other. In 1866, Desiré Gernez wrote to his former colleague Pasteur, describing the result of an interesting experiment⁴. Following on from Pasteur’s work, Gernez had discovered that the addition of seed crystals of pure enantiomer to a racemic solution of the tartrate — one containing equal amounts of the two enantiomers — yielded, not a racemic solid, but crystals of the same chirality as the seed. Separations based on this observation have become known as ‘resolutions by entrainment’⁵ and are part of the armory of the modern-day chemical-process developer.

Not surprisingly, it was chemical engineers, interested in designing continuous crystallization processes, for whom seeding (or secondary nucleation, as they termed it) became a central issue. In 1934, Ting and McCabe⁶ showed that solutions of magnetium sulphate could be nucleated more reproducibly at moderate supersaturations in the presence of seeds. Today, commercial crystallization processes operate at supersaturation densities of perhaps 20%, ensuring that seeding levels are always high.

Some clever experiments⁷ in the 1970s on the seeded nucleation of enantiomers of sodium chloride revealed that, as long as the supersaturations were not too high, all the crystals were enantiomerically identical to the seed. The experiments also showed that the new crystals originated from the seeds through their contact with the crystallizing vessel. We now know that secondary nucleation, and hence seeding, can often be more effective because of mechanical and liquid-shear damage at the seed surface⁸. Such damage would remove potential nuclei from the seed, allowing them to become free-growing crystals. This seems to be a tantamount reflection of what Cacciuto et al.⁹ have now shown.

Time, I think, for some new experiments. Roger J. Davey is at the Molecular Materials Centre, Department of Chemical Engineering, UMIST, Manchester M60 1QD, UK.

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2. Garside, J. & Davey, R. J. From Molecules to Crystallizers — An Introduction to Crystallization Ch. 3 (Oxford Univ. Press, 2000).