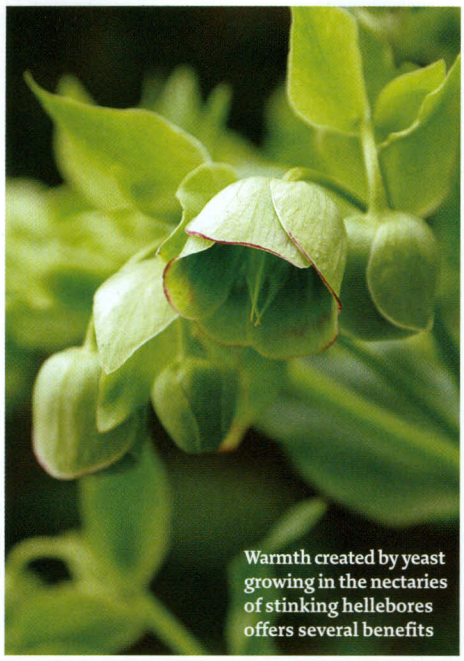
Central heating for hellebores

Some flowers warm themselves by absorbing heat from the sun, some even track its movement across the sky. Others, such as the titan arum and some of its smellier relatives, generate heat metabolically to encourage their evil-smelling odours to waft further afield. Spanish researchers have now found a third means by which flowers can raise their temperature – by harnessing heat generated by yeasts living in their nectaries.

Carlos Herrera, an ecologist at the Doñana Biological Station in Seville, knew from earlier studies that many flowers harbour sugar-loving yeasts. These specialist yeasts are spread from plant to plant by bumblebees, and once inside a nectary they proliferate rapidly. On the face of it, the yeast benefits at the plant's expense, consuming nectar meant to attract pollinators. Yet these yeasts are so common that Herrera suspected there might be something in it for the plants too.

When yeasts break down sugars, they generate significant amounts of heat. Were these plants trading sugar for warmth,



Warmth created by yeast growing in the nectaries of stinking hellebores offers several benefits

Herrera wondered. He decided to test his hunch in a plant that could benefit from a little extra heat, the winter-flowering stinking hellebore (*Helleborus foetidus*).

Herrera and his colleague María Pozo studied hellebores growing in the mountains of south-eastern Spain. They found that the flowers almost invariably contain yeasts, often at very high densities. The question was whether the yeast made any noticeable difference to temperature. To find out, the biologists compared yeast-free flowers, kept 'clean' by the exclusion of bees, with flowers they had inoculated with a culture of yeast collected from a bumblebee's tongue.

The effect was dramatic. Flowers with yeast in their nectaries had markedly warmer interiors than flowers without, and the more yeast, the bigger the difference (published online in *Proceedings of the Royal Society B*). On average, nectaries were 2°C warmer, but 7°C 'was not exceptional'. Warmer nectaries kept the air within the flower significantly warmer than outside.

For winter-blooming plants like the hellebore, a little extra warmth can pay dividends. Pollen germinates and pollen tubes grow faster when it's warmer, improving the prospects of successful fertilisation. Extra heat also encourages fruits to develop and seeds to grow larger. But first the flower has to be pollinated, and few insects are active when hellebores bloom. Those that are, suggests Herrera, might find a warm flower that bit more attractive. 'In the early part of the flowering season, when there's regular snowfall and daily frosts, floral warming will benefit pollinators directly by providing some sort of small thermal oasis.'

Phew, not a scorcher!

Don't water your garden in the noonday sun or your plants may suffer from sunburn – or so it's said. The belief that drops of water focus the sun's rays like tiny magnifying glasses, burning and scorching leaves, is deeply ingrained in gardening lore. Some even believe forest fires can start this way. Yet no one had gone to the trouble of checking if it's possible. 'It's not a trivial question,' says Gábor Horváth, of the environmental optics laboratory at Eötvös University in Budapest. He and his colleagues decided to investigate.

An experiment with small glass balls laid on the surface of maple leaves proved that transparent spheres can indeed focus the sun's rays to an intensity that causes burns. But no drop of water can focus sunlight quite so effectively, partly because water refracts light less powerfully than glass, and partly because water droplets are rarely spherical.

The shape of a drop depends on how smooth and wettable the surface of a leaf is. On a maple leaf, for instance, drops spread and flatten, while on water-repellent ginkgo leaves, drops hold their shape better and stand taller. In tests, however, even the most spheroid-shaped drops failed to cause burns. In optical terms, the drops were unable to focus sunlight to a point on the leaf, so the heat was never intense enough to burn (*New Phytologist*, vol 185, p979).

Horváth calculated that the only conditions where drops might cause burns would be if they were held off the leaf surface – removing any cooling effect of water – and high enough to bend the light to a point on the leaf itself. This might be possible with hairy leaves, where drops are trapped among the hairs – and so it proved. Tests with the waxy-haired leaves of the floating fern *Salvinia natans* resulted in scorch marks after two hours in bright sun. As Horváth points out, burning is unlikely in nature because the drops would almost certainly roll off long before any harm is done. As for starting forest fires, he advises taking that with a pinch of salt.

Droplets of water are said to scorch leaves by focusing the sun's rays – but do they?

Even so, it's still best not to water at midday because it's wasteful, as much of it will evaporate. Stick to early evening and stick to the parts that need it – the roots.

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