PHOTOSYNTHESIS

Red but not dead

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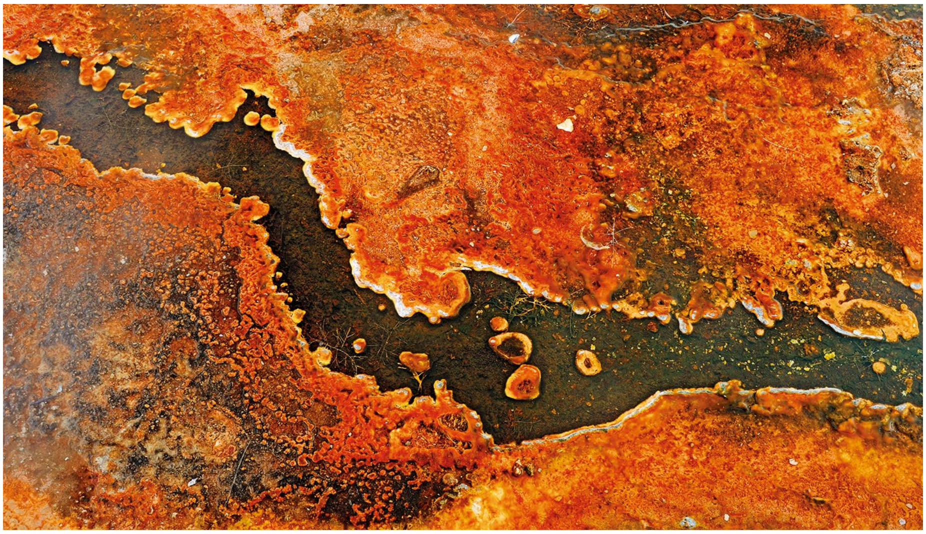

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The photosystems of all plants and almost all cyanobacteria use the pigment chlorophyll *a* (Chl *a*) to absorb light energy and convey it to reaction centres where this energy is used to split water. This has led to the idea that light absorption by Chl *a* sets a lower limit for the energy needed to drive photosynthesis. However, a group led by William Rutherford of Imperial College, London, have shown that the cyanobacterium *Chroococcidiopsis thermalis* employs an alternative pigment, chlorophyll *f*, to capture light at the far-red end of the spectrum, well below the 'red-limit' of Chl *a*, and so survive in highly shaded conditions.

C. thermalis is an extremophile capable of living in harsh environments such as hot springs, including those at Yellowstone National Park, although the strain used in these experiments was originally isolated in a sample of soil from Greifswald, East Germany in the early 1960s. *C. thermalis* will also grow under far-red light, that is wavelengths around 750 nm, some 50 nm longer than that absorbed by Chl *a*. In such conditions, around 10% of its chlorophyll pigments are Chl *f*. This has the effect of extending the action spectra of both photosystem I and photosystem II to longer wavelengths, compared to *C. thermalis* grown under white light and so lacking Chl *f*. Using sophisticated spectroscopy, the researchers were able to see that, in the cyanobaterial phototosystems, Chl *f* was replacing Chl *a* as the primary electron donor at the heart of the reaction centre, as well as forming antenna complexes to collect photons of far-red light.

C. thermalis is not the only cyanobacterium to operate below the red-limit. *Acaryochloris* has previously been shown to achieve this feat by replacing all its Chl *a* molecules with another variant, Chl *d*. However, *C. thermalis* can exist on even lower energy light than *Acaryochloris*, and tune its photosystems to the prevailing light. Further study of *C. thermalis* may thus provide routes to engineer crops able to grow in a wider range of conditions. Also, by showing that the red-limit is not an absolute barrier this study increases the range of habitats that could perhaps support photosynthetic life, both on Earth and on the multitude of exoplanets increasingly being discovered.

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