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On being and seeing red

The northern cardinal (*Cardinalis cardinalis*; pictured) owes its striking appearance to red ketocarotenoid pigments that are converted from yellow pigments in its diet. In *Current Biology*, Toomey *et al.* characterize the enzymatic pathway for this conversion in birds and fish (M. B. Toomey *et al. Curr. Biol.* https://doi.org/10.1016/j.cub.2022.08.013; 2022).

As well as being found in red feathers, ketocarotenoids are made in red 'cone' cells in the eye that detect red light. The gene encoding the enzyme CYP2J19 was the most highly expressed of the genes enriched in red cone cells compared with other cone-cell types. Mammalian cells engineered to express CYP2J19 converted yellow pigments into reaction intermediates, and other cells that were engineered to express an enzyme called BDH1L converted these intermediates into ketocarotenoids. Toomey *et al.* found both enzymes in feather follicles from domestic red canaries (*Serinus canaria* forma *domestica*).

The team eliminated ketocarotenoid production in *Danio albolineatus* fish by deleting genes that are closely related to those encoding CYP2J19 and BDH1L in birds. Thus, the pathway for ketocarotenoid synthesis is similar in fish and birds.

Natasha Bray

Climate change

Declining crop yields limit bioenergy potential

Gernot Wagner & Wolfram Schlenker

Global-warming projections that rely on bioenergy strategies to offset carbon dioxide emissions could be unduly optimistic, according to a study that accounts for how climate change affects crop yields. **See p.299**

Climate change is beset with unpleasant surprises[1]. Yields of maize (corn), wheat, rice and soya beans all fall precipitously when temperatures exceed certain thresholds – for example, 29 °C for maize[2]. These four staple crops together account for 75% of the calories consumed by humans[3], so the non-linear temperature dependence of their yields calls for rapid action to avoid the tipping points, either by limiting the carbon dioxide emissions that are warming the planet[4] or by relocating crop fields on a vast scale – probably both. But efforts to curb global warming rely increasingly on the use of plant biomass to reduce emissions, and introduce a feedback loop that endangers attempts to meet essential climate goals, as Xu *et al.*[5] report on page 299.

Plants absorb CO_2 from the atmosphere during photosynthesis, and this process can be used to capture and store CO_2 when fuels made from plant biomass are burnt without releasing the CO_2 back into the atmosphere; this results in a source of energy that has 'negative' emissions. Most models that estimate the costs associated with a changing climate assume that this technology, known as bioenergy with carbon capture and storage (BECCS), will be ramped up substantially over the coming decades[6,7]. And with good reason – an increase in the deployment of new, improved technologies is typically a safe assumption. However, Xu and colleagues' analysis shows that, as time goes by and the world warms, falling crop productivity rates will reduce the effectiveness of BECCS, highlighting limits of this new technology.

The authors describe the effect as a 'positive' feedback loop. There is, of course, nothing positive about this particular feedback in the conventional sense of the term: increased global average warming leads to reduced crop yields, which, in turn, decreases carbon capture through BECCS, inducing further increases in global average warming. In this scenario, two negative links combine to create one hot mess.

Climate–economy modelling has undergone a substantial shift over the past decade, as researchers have warmed to the idea that these models can include large quantities of