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INSIDE JEB

Cabbage whites have a unique take on polarized light

A cabbage white butterfly (*Pireis rapae*). Photo credit: Adam Blake.

Cabbage white butterfly females are choosy. They aren't happy to deposit their eggs on any old bit of foliage; for them, it's members of the Brassicaceae family or nothing. And, when Adam Blake and colleagues from Simon Fraser University, Canada, tried to interest the picky insects in other pieces of vegetation, it turned out that the degree of polarized light reflected by leaves played a large part in the choices of the butterfly mums-to-be. The selective females prefer to settle on leaves that reflected 25–35% of linearly polarized light, like tasty cabbage leaves, but turn up their noses at potato plants that reflect 45–55% linearly polarized light. But how were the keen insects' eyes able to distinguish between the degree of linearly polarized light reflected by cabbage leaves and that reflected by the verdant foliage of potato plants? Intrigued by the pernickety females, Blake and PI Gerhard Gries set the insects a TV quiz to get to the bottom of how they perceive the difference between potato leaves and cabbages.

Having already discovered that cabbage white butterflies prefer pictures of cabbage-shaped plants, Gina Hahn, Hayley Grey, Shelby Kwok, Deby McIntosh and Blake set about adjusting the colours and degree of linear polarization present in the light emitted from a TV screen showing a shot of a cabbage plant to find out how the changes affected the insects' preferences. However, Blake explains, 'Despite using identical monitors controlled by the same hardware and software, it took a great deal of effort to get both monitors to output similar colours (as measured by their spectra) when showing identical images'. Eventually, after months of painstakingly tinkering to synchronize the screens' colours, the team was able to offer the butterflies a choice between two cabbage images – one with colours that had been tweaked – to begin to understand how light polarization affects their perception of colour.

The team removed red or blue shades from the cabbage images, in addition to altering the degree of light polarization, and, as the cabbages' colours changed, the butterflies' preferences began shifting all over the place. In one case, the butterflies consistently preferred bluer cabbages (lacking a hint of red) with 51% polarization over bluer cabbages with 31% polarization, while they preferred yellower cabbages (with no blue in their spectrum) when the light was horizontally polarized with 31% polarization, but switched preference to 51% polarization when the light was vertically polarized. The team realised that instead of depending on one, or a combination of two, types of light receptors in their retina – tuned to either red, green or blue light – to detect polarized light, the cabbage whites must be using all three colour-tuned photoreceptors. In addition, the insects were perceiving the polarized light differently, depending on the shade and brightness of the colour.

And when the team compared the cabbage white's colour preferences with those of other butterflies, it was apparent that the impact of polarization on the cabbage white's perception of colour is unique. Blake explains that horizontal polarization makes shades of green brighter for swallowtail butterflies; however, the cabbage white's preferences revealed that the effects of light polarization did not make any particular colour brighter in their eyes. 'Cabbage white butterflies respond to polarized light differently from not just other butterflies, but from all of the other polarization-sensitive animals studied thus far', he says.

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