Relationship between the retinal organization and visual functions in *Papilio* butterflies

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The foraging behavior of *Papilio* butterflies strongly depends on the wavelength and intensity of visual stimuli. Their compound eyes are furnished with six classes of spectral receptors (UV, V, B, G, R and BB), Which are embedded in the ommatidia, each bearing 9 photoreceptor cells, in three different combinations. How do the butterflies use these receptors?

We first measured the wavelength discrimination ability in foraging *Papilio* to identify the receptors contributing color vision. We found that the *Papilio* can discriminate 1nm difference at around 430, 480 and 560nm. A simulation using the noise-limited color opponency model reasonably reproduced the behavioral data with the UV, B, G and R receptors, indicating that the color vision is tetrachromatic based on those receptors.

Intensity was found to be important as well, especially for landing. We systematically changed the intensity contrast between the target and the background and measured the successful landing ratio. When the contrast was very small, *Papilio* could not land on the target although they approached it. Honeybees use G receptors to detect intensity contrast of a small target, but *Papilio* appeared not to depend only on G receptors.