The function of ocelli in Hymenopterans: Spectral and Polarization sensitivity

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Acquiring relevant and accurate visual information is crucial in order to make quick decisions during navigation. Most insects possess two or three dorsal ocelli, which are small single lens eyes situated on top of their heads between the compound eyes. Even though the optics of ocelli generate relatively low resolution images, their superior speed and sensitivity means that they can improve the visual performance of insects by complementing and modulating compound eye functions (Mizunami, 1995). While it is known that ocelli contribute to flight stabilization in flying insects, their function if walking insects remains unclear. Here, we compare the physiological and anatomical organisation of ocelli between walking and flying insects. Our electrophysiological studies show that both honeybees (*Apis mellifera*) and the Australian bull ants (*Myrmecia vindex*) possess two photoreceptor types with peak sensitivities at 360 nm and 500 nm, respectively. All photoreceptors in honeybees are polarization sensitive and their preferred e-vector orientations differ across the visual field. We discuss the functional significance of the distribution of polarization sensitivities by highlighting the information the ocelli are able to extract from the bee’s visual environment. In bull ants, seven out of 15 photoreceptors are polarization sensitive. We tested behaviourally whether inbound nocturnal *M. midas* foragers respond to changes in the overhead polarization pattern by rotating a polarizer by ±45°. Half of all intact and ants with occluded ocelli respond to rotational changes in the polarization pattern. Importantly, in the absence of compound eye information, tested by either occluding the entire compound eye or selectively the Dorsal Rim Area, 86% and 67% of ants still respond to e-vector rotations. This indicates that ocelli provide directional information for navigation in ants, which dominates in the absence of landmark information from compound eyes.