

Stomatopod crustaceans and how they Stoke up Newton

NJ Marshall¹, TW Cronin², N Roberts³, V Gruev⁴, T-H Chiou⁵

¹ Queensland Brain Institute, The University of Queensland, Brisbane, Queensland, 4072, Australia

² Department of Biological Sciences, University of Maryland Baltimore County, MD 21250, Maryland, USA

³ Ecology of Vision, Biological Sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG, UK

⁴ Department of Computer Science and Engineering, Washington University, MO 63130, Missouri, USA

⁵ Department of Life Sciences, National Cheng-Kung University, Tainan City 701, Taiwan

justin.marshall@uq.edu.au

Stomatopods love light. These shy, violent shrimps detect more of the spectrum than any other animal and manipulate light through pigments, molecules, optical elements and cuticular nanostructures in ways that have biologists reaching for physics text books. As well as their neatly spaced twelve spectral sensitivities (from 300-720nm), several species also sample polarised light comprehensively with receptors arrayed at 0,45,90,135° and with both left and right handed circular polarisation receptors.

Instead of a desire (through evolution) to construct a dodecahedral colour space or a Poincaré sphere to fully describe light, we hypothesise that mantis shrimps are more interested in the examination of signals and surfaces, particularly those from their own bodies. Are they nature's little spectrophotometers and ellipsometers? Do they encode Stokes parameters and present spectra, not chromatic ratios, to a brain-based look-up table?

This presentation will summarise our knowledge of stomatopod vision and describe some of the coloured and polarised light reflection elements that stomatopods apparently use to 'talk' to each other. Structural reflections mechanisms, including scatter and selective e-vector reflection or transmission, as well as pigmentary mechanisms, construct this language.

Three bio-inspired spin-off directions from this research include: early cancer detection, optical data storage for computing and satellite design.