Structure and function of 3-D photonic crystals in weevils (Coleoptera: Curculionidae)

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Beetles display a remarkable diversity of colour patterns, including iridescent hues and ultraviolet reflectance. The iridescence of the weevil clades Eupholina, Pachyrrhinchini, Naupactini, and other brightly-coloured entimine species is unique among beetles: while other groups derive their colour from pigments or two-dimensional multilayer reflectors, the colours of entimine weevils are produced almost entirely by three-dimensional photonic crystals analogous to those found in mineral opal and titanium oxides. In this complex iridescence mechanism, a nanoscale three-dimensional lattice of chitin and air reflects certain wavelengths of light with constructive interference, producing vivid structural colours. In entimines, this lattice forms within the lumen of the scales during pupation, as an aggregation of small, variously-oriented crystalline domains.Using electron microscopy and short-angle X-ray scattering (SAXS), my collaborators and I have examined the lattice structure within the scale lumen of twelve weevil species selected to represent all major clades of the family Curculionidae. Here I present the first hypothesis for an evolutionary pathway by which these highly-ordered photonic structures could have arisen, and note ecological correlates which suggest a selection mechanism.