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SCIENCE OF THE ENVIRONMENT

Morpho cyrpis, Choco rainforest

Light Scatterers

Many of the colours we encounter every day, including paints and dyes, are produced by pigments, chemicals that selectively absorb certain colours of light. But many animals, especially butterflies, instead produce colours by using nano-scale structures, of a similar size to the waves of light. These selectively reflect certain wavelengths of light, which give them some of the most breathtaking colouration.

Light and colour. Light is made up of waves, different colours are due to different lengths of these waves. Small particles or structures can cause different wavelengths of light to be scattered. For example, water particles in the air or the thin film of a soap bubble can separate the different lengths of light waves, producing a rainbow. Butterfly wings are covered in tiny scales that give the wing colour, either by containing pigments, or by having nano-structures that reflect certain wavelengths (or both).

Heliconius erato cyrbia
Ecuador

Heliconius erato demophoon
Panama

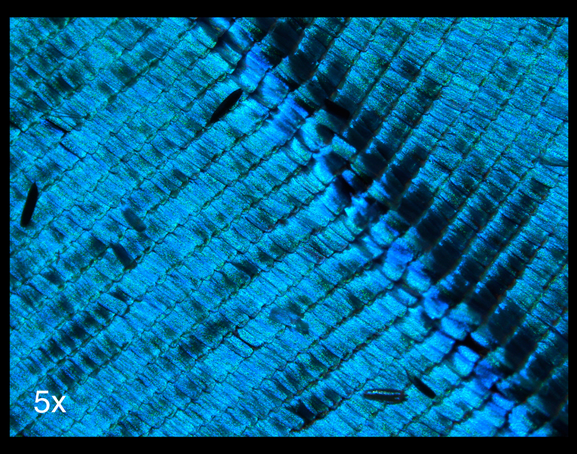
Heliconius butterflies have black, red and yellow colours that are due to pigments, but some have a shiny blue or blue-green colour that is caused by scale nano-structure. The difference between a black and a blue scale is the shape of the ridges on the scale. Blue scales have ridges made up of several layers, while on black scales the ridges are curved and not layered.

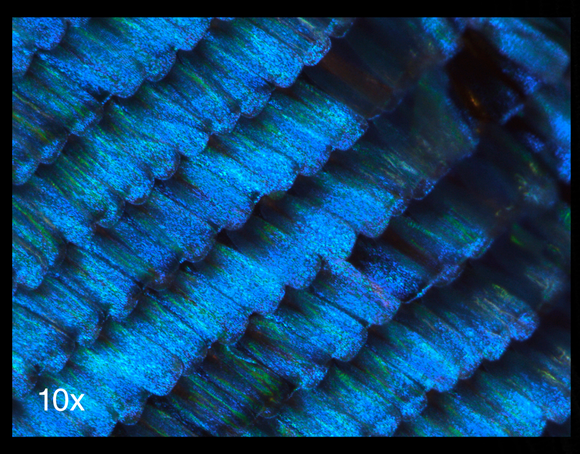
Structural colour. Ordered structures, either layers, lattices or grids, that are a similar size to the wavelength of light, can cause just one wavelength of light to be reflected, producing a single colour. The remaining wavelengths are absorbed by pigments located below the structure.

Morpho melenaus

Arcas imperialis

How to make a blue scale. Whether the butterfly has blue or black scales is determined by its genome. The genome is a chemical code, containing all the information needed to make the whole butterfly. Small differences in this code control how the scale is formed and so what colour it becomes.





Scales of *Morpho melenaus*

Helping us make better colors. We are starting to understand how the butterfly genome controls the formation of nano-structures. This could lead to new technologies for producing nano-structured surfaces with a wide range of applications from solar panels to decorative paint.