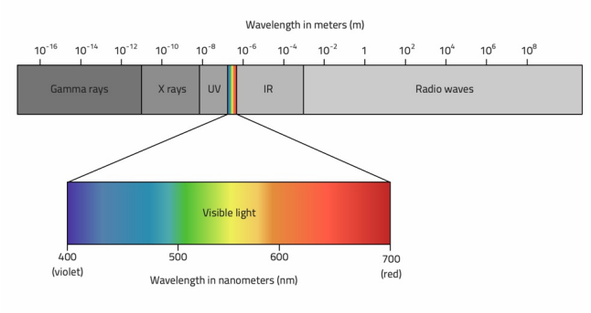
Butterflies: Heros of our Future?

Because of their small mass and thin wings, butterflies have a bad thermal capacity, meaning they can overheat in seconds when exposed to the sun. To adapt to this, they have evolved intricate ways to cool themselves, inspiring scientists to develop innovative cooling materials that could help solve climate change.

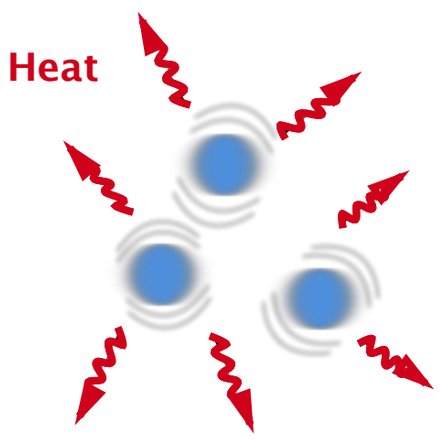
Cool wings

Researchers at Columbia University and Harvard University used infrared hyperspectral imaging technique to accurately measure temperature in butterfly wings. Hyperspectral imaging process determines which part of the electromagnetic spectrum is reflected. This process is used because butterfly wings are translucent in the mid-infrared spectrum.



What is heat?

Heat is electromagnetic radiation generated by the vibration of molecules. The more molecules a material can have on its surface, the more it can dissipate heat. Structure can thus determine how quickly a material can release heat. Thick and hollow materials composed of corrugated shapes such as waves or tubes can cool off much faster than this solid flat-surfaced materials because they have more exposed surface area. This is why radiators have so many folds —to easily dissipate heat!

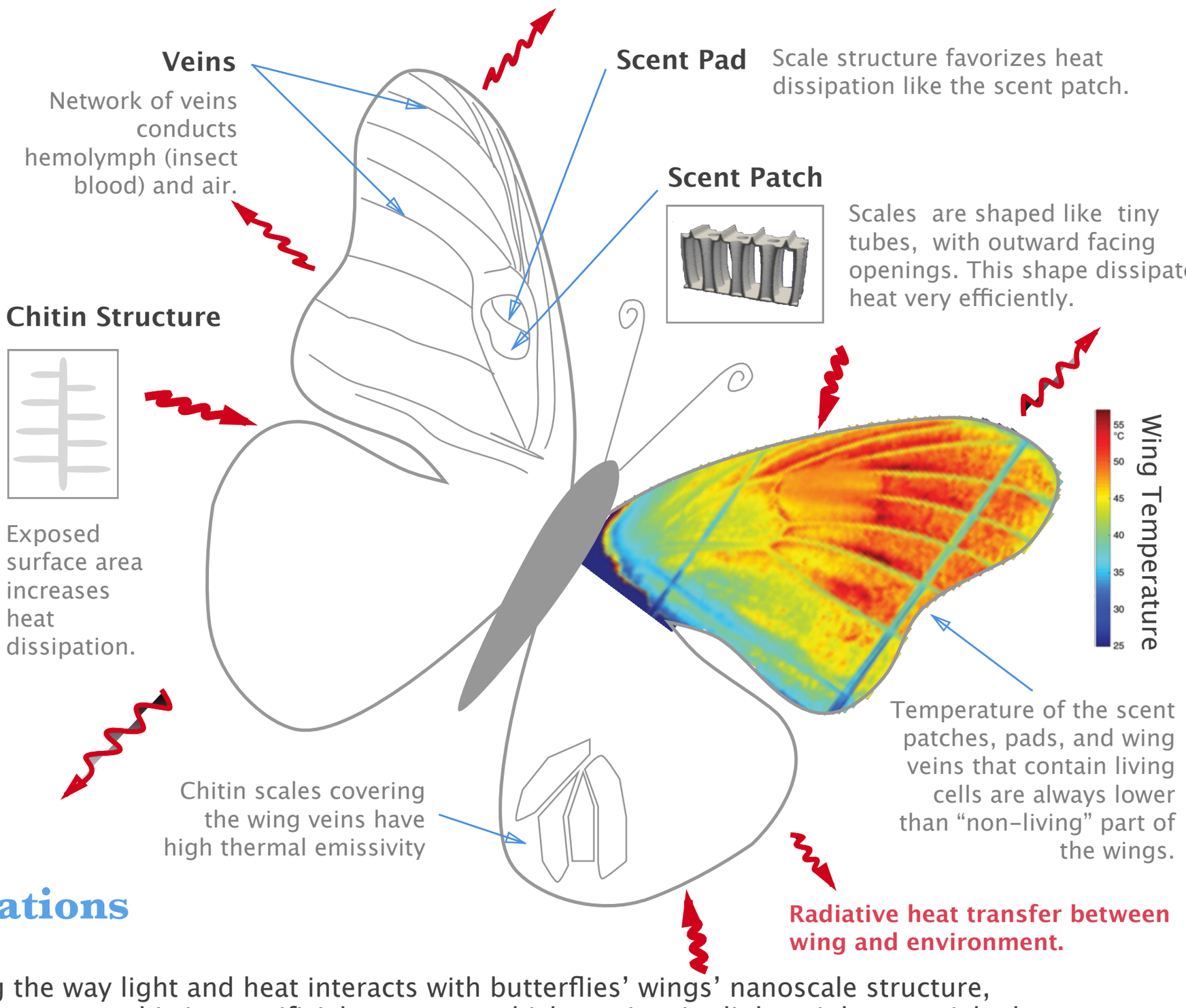


Thermodynamic wing properties:

Butterfly wings' spectral properties across wavelengths beyond the visible are tailored to help them better adapt to the electromagnetic radiation environment. The researchers found that the wing is more of a dynamic living structure than an inert membrane. It is composed of "living" parts (scent patch, sent pad, and veins), as well as "non-living" parts (inter-veinal regions). Two factors enable to keep butterfly wings cool:

1. Chitin layers
Chitin is a derivative of glucose, found in insect exoskeletons, wings, etc. Thicker chitin layers over "living parts" facilitates heat emission. The chitin layer is thinner over "non-living" parts, they do not have as high thermal emissivity (these parts are not as easily damaged by heat).

2. Nanoscale structures
The researchers found that scales covering the "living parts" of the wing have different structures that radiate heat in different ways. Microscopically there are more "radiators", thus more efficient heat dissipation.



Applications

By studying the way light and heat interacts with butterflies' wings' nanoscale structure, researchers can turn this into artificial processes which can inspire lightweight materials that eliminate heat very efficiently. This can help scientists develop an effective variety of "cool roofs" that could completely offset global warming.