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Hornet cooling theory creates stir

Proposal of vespine heat pump stings insect researchers.

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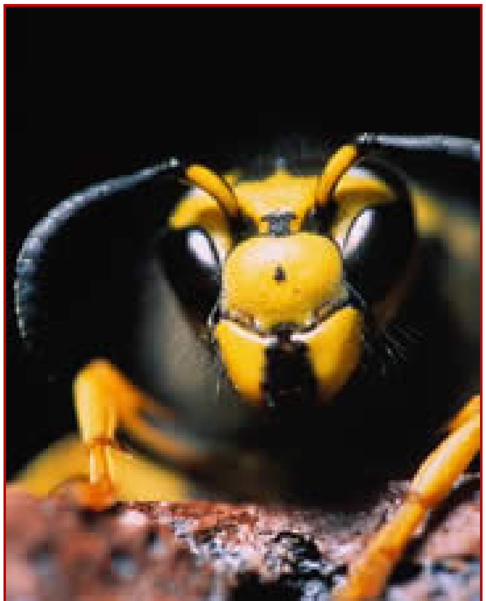

Hornets face air temperatures of more than 40 °C.
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How does a busy hornet keep cool? Its skin is an electrical heat pump, claim Israeli researchers - the first suggestion of such a mechanism in an animal.

The idea has stung insect specialists. Hornets are unlikely to have a heat pump, and don't need one anyway, they argue.

It's a bold proposal, admit Jacob Ishay and colleagues at Tel Aviv University, who came up with it. But a pump could answer a lot of questions about how hornets, wasps and even other insects stop themselves overheating during a day's work.

Foraging in sunlight, the insects can face air temperatures of more than 40 ºC, but have no sweat glands to help them dispose of excess heat. The thorax, which contains a hornet's flight muscles, can become hotter still. Physiologists think that heat from here is dissipated through the body by a blood-like fluid called haemolymph.

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Hot topic

The team used a heat-sensitive camera to photograph oriental hornets (*Vespa orientalis*) flying round a nest near their lab. They saw evidence that parts of the insects' bodies are often several degrees cooler than their surroundings.

Removing heat from a surface that is already cooler than its surroundings - as in a commercial refrigerator - requires the right hardware, not to mention a source of energy. The structure of the hornet's outer layer, called the cuticle, is well suited to the task, says Ishay's team.

They suggest that the cuticle works as a thermoelectric heat pump. Such devices use electrical energy to shunt heat the wrong way - from cool to hot. The process relies on thermocouples. These are junctions within electrical circuits where conductors of different materials meet. If a voltage is applied across one, heat moves from one side of it to the other.

Commercial thermoelectric heat pumps have a stack of thermocouples, usually several centimetres thick. They are used to cool a huge range of substances, from water in the office drinking fountain to the motor in a dentist's drill.

The hornet's cuticle has the same structure, albeit packed into a thickness of a few thousandths of a millimetre, claims Ishay's team. Generating power would not be a problem - as well as the insect's metabolic energy, the cuticle itself generates a voltage when exposed to sunlight or ultraviolet rays, much like a man-made solar battery.

Sting in the tale

Other researchers have greeted the proposal with scepticism. "It needs a lot more evidence," says Julian Vincent of the University of Bath, UK, who studies insect cuticles.

Vincent suspects that the cuticle is not arranged in layers, but is composed of ordered molecules that just look like layers under the microscope. What's more, he disputes the assertion that hornets are cooler than their surroundings. Although the insects look cold in the thermal photographs, the air around them could be colder still, he warns.

The team needs to nail down the details of how heat moves between a hornet and its surroundings, agrees thermodynamics expert Geoffrey Hammond, also at the University of Bath. The hornets' apparent coolness in the photographs could be due to their shiny surfaces, which may

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reflect heat as well as light.

"There's a lot more work to be done," says David Bergman, a member of the Tel Aviv team. The researchers now hope to catch a hornet's heat pump in action and find out whether similar pumps are present in the hornet's relatives, such as wasps.

References

1. Ishay, J. S., Pertsis, V., Rave, E., Goren, A. & Bergman, D. J. Natural thermoelectric heat pump in social wasps. *Physical Review Letters*, **90,** 218102, (2003). **|Article|**

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