Social insects: building services engineers of the natural world

By

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Insects

- Over 1 million described species
- Over 75% of the total number of known species
- First species to evolve social systems
- First species to fly
- Flight caused many species to be the first warm-blooded (endothermic) animals
- Among the first thermoregulatory animals

The hot blooded insects. Heinrich (1993), Harvard University Press, MASS, USA.
Nest building social insects

Oriental Hornet (*Vespa orientalis*)
- Nest building below ground
- Lay eggs in combs
- Eggs hatch and form a cocoon from silk spun by the larvae
Oriental Hornet nest in Lab.

Orientation of cocoons.


Current v time for temperature from 20°C to 33°C. Kirshhoim, Ishay (2000).
Dark current and photoelectric effect of hornet silk. Intermittent light of 365 nm and intensity of 100mW:cm². The specimen was measured at 26°C. Kirshhoim, Ishay (2000)
Thermoelectric devices and Figure of Merit

\[ ZT = \frac{\delta S^2 T}{\lambda} \]
Nest building social insects

Oriental Hornet (*Vespa orientalis*)
- Adult cuticle harvests solar energy
- Digging activity occurs during high solar insolation
a) Digging activity of the Oriental hornet worker. The Oriental hornet digs its nest (1) and enlarges it to allow for the building of additional comb cells (2). The hornet picks a clod of earth in its mandible (3), flies out of the nest, drops the clod of earth (4), and returns to repeat this process.

b) The brown-coloured hornet has yellow segments on its head: (1, 2), and on the dorsal side of its abdomen (3 and 4).

c) absorbance of brown cuticle, yellow cuticle, and yellow cuticle after the removal of yellow pigment granules.

a) Cross-section through the cuticle of an adult hornet brown cuticle. Shown are the hairs extruding from the exocuticle. The cuticle is made up of about 30 layers whose thickness diminishes from the exterior to the interior.
b) Cross-section through the cuticle of an adult hornet containing yellow granules.
c) The barrel-like shape of the yellow pigment granules (about 500 nm in size) and that they are tightly packed.

ATF images and profile of brown and yellow epicuticle

Conclusions

- Silks provide multifunctional capabilities that give animals such as wasps and hornets adaptive advantage.

- Silks play an active role in controlling biological processes and environmental conditions.

- Nanocomposites enhance energy storage and harvesting properties.
Questions

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