How long do insects last?

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Researchers from Trinity College Dublin have shown that although insects are made from one of the toughest natural materials, their legs and wings can wear out over time. The findings have been just published in the *Journal of Experimental Biology*.

"The single biggest cause of failure in cars, airplanes and other mechanical structures is material fatigue," said Dr. Jan-Henning Dirks, who studied the biomechanics of insects together with Eoin Parle and Professor David Taylor at Trinity's Department of Mechanical and Manufacturing Engineering. "For quite some time it has been known that this kind of fatigue behaviour easily happens in some materials, but far less in others. That's why engineers are constantly looking for ideas to design safer, more durable types of materials."

But until now nothing was known about the fatigue properties of the second-most common natural material in the world: insect cuticle.

Insects are regarded as one of the most diverse groups of animals in the world, yet they have one thing in common: they all are made from a material called cuticle. "The insects' exoskeleton supports them in a way our bones support our body," said Dirks. "At the same time the cuticle also acts as a kind of protective skin. Cuticle is an extremely versatile biological material. If we understood how it acts under repeated loads, we might be able to design more durable biomimetic materials for many kinds of applications."

As a first step, the team looked at the cuticle of the desert locust. "These

locusts are capable of flying across oceans and deserts, often for days or weeks at a time," said Parle, who is writing his PhD thesis about the mechanical properties of insect cuticle. "Their wings beat hundreds of thousands of times, and with their hind legs they perform thousands of jumps."

To measure the fatigue properties of the cuticle, the team took samples of the legs and wings and mechanically simulated the repeated loading that occurs in wing beats and during jumping. The researchers were able to show that both structures can withstand hundreds of thousands of cycles, with the legs being notably more resistant to fatigue. "Our results also show that due to their shape and fibrous material the legs are very well adapted to withstand the types of failure that might occur in jumping and kicking," said Parle.

"For the first time, we now actually know that insect cuticle shows material fatigue after repeated loading." said Taylor. "These results are obviously just a first step. Studying insect cuticle is not only thought-provoking from the engineering point of view, where our findings might help us to develop more durable composite materials. Our results are also interesting from the biological perspective, where we can learn more about how insects evolved to become one of the most successful groups of animals."

More information: Dirks, J., Parle, E. and, Taylor, D. Fatigue of insect cuticle, *The Journal of Experimental Biology* (10) 2013.

Provided by Trinity College Dublin

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