

Researchers establish how super strong insect legs are

May 18 2012



Grasshopper

(Phys.org)—Researchers from Trinity College Dublin have shown that insects are made from one of the toughest natural materials in the world. The study's findings have been recently published in the leading international biomechanics publication, *Journal of Experimental Biology*.

"All [insects](#) are made from a material called cuticle," said Dr. Jan-Henning Dirks, who studied the properties of this amazing material together with Professor of Mechanical Engineering David Taylor at the Department of Mechanical and Manufacturing Engineering.

Insect cuticle is the second most common natural material in the world after wood, and it is one of the most versatile. "The whole outer body of

the insect is made from cuticle." said Dirks. "Imagine an entire house built out of one single material: the roof, the walls, the windows, even the door joints. The versatility of cuticle is amazing. We are surrounded by it every day, yet we know almost nothing about its properties."

The hind legs of grasshoppers were one of the first samples the two researchers looked at in detail. "During jumping and kicking, grasshopper legs have to withstand very large forces," said Taylor. "Thus we were wondering whether the legs were in any way special?"

The two researchers then measured the force needed to bend and break single grasshopper legs. They found that although the legs are not very stiff, surprisingly they can withstand remarkably high forces before actually breaking, even when small cuts were introduced to deliberately weaken them. "Usually if you want a high fracture toughness you have a high stiffness," said Dirks. However, their experiments show that grasshopper legs have an almost unique combination of relatively low stiffness with a high toughness.

"The toughness we measured for the grasshopper leg is amongst the highest of any biological material," said Taylor. "The cuticle is tougher than bone, and as good as antlers or horn." This gives the insect leg an exceptional ability to tolerate defects such as cracks and damage, which might occur during jumping or fighting.

The experiments also revealed that stiffness and toughness of the [grasshopper](#) legs strongly depend on the amount of water in the material, with a trade-off between both properties. With less water the cuticle becomes stiffer, however also more brittle. "Now we know how remarkably tough cuticle can be, we want to understand how exactly it achieves this toughness." said Dirks. "This might help us to develop bioinspired new lightweight and durable materials."

Provided by Trinity College Dublin

Citation: Researchers establish how super strong insect legs are (2012, May 18) retrieved 11 July 2024 from <https://phys.org/news/2012-05-super-strong-insect-legs.html>

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