# At W&M, a new spin on arachnids

## Scientists see the future of man-made materials by studying spider webs

The brown recluse is a spider that has a venomous bite but poses only a low risk to healthy humans. photo Courtesy of Schniepp Lab

Schniepp

BY BEN SWENSON CORRESPONDENT

WILLIAMSBURG — Hannes Schniepp is not spinning a tale when he envisions a world in which everyday items such as water bottles and car tires are made in the same manner as spider webs.

Schniepp is a professor of applied science at the College of William & Mary and lead author of a study in the journal Nature Communications revealing the intricate molecular structure of spider silk. The findings could dramatically improve the relationship people have with the manufactured products that make civilized life easier.

The paper, co-authored by eight additional William & Mary researchers from different departments, was one of three studies about spider silk that happened to be published in academic journals by members of Schniepp's team within a couple weeks. The other papers explained findings about the adhesive properties and microscopic mechanics of spider silk.

Schniepp and his team primarily have studied the silk of the brown recluse, a spider that has a venomous bite but poses only a low risk to healthy humans. They have analyzed webs from several types of spiders — some people have even given Schniepp interesting spiders they've found in backyards — but the researchers prefer the brown recluse because of the shape of the silk it spins, which is flat like a ribbon instead of cylindrical like a hose.

"Natural materials have a beautifully complex structure," Schniepp said. "The same is true for spider silk."

Schniepp likens his team's research to zooming in from afar on Google Maps, where viewers can see the planet, a continent, country, state, city and, finally, their own home. They similarly analyzed the brown recluse's web at different levels, learning something about the material from each perspective.

In 2018, the team discovered that spider silk, which is 100% protein, is made up of microscopic fibers, called nanofibrils, that are about 10,000 times smaller than the width of a human hair. More recently, Schniepp said, they used sophisticated techniques to determine that the small fibers are made up of multiple molecular structures, such as a helixes and beta sheets, which are long chains of proteins that form parallel lines by zigzagging.

This complexity makes spider silk tremendously strong. The natural material is five times stronger than steel, but much more flexible. Why such an arrangement of different structures at the molecular level creates such a powerful fiber is one focus of Schneipp's research.

"That complicated structure of helixes and beta sheets — that is not there by accident," Schniepp said. "All this complicated structure that we discovered there has a function and purpose. … With these papers, we found out what it is, but don't yet know how to make it."

When scientists can synthesize spider silk from manmade proteins, the applications are endless. Technicians could create biomedical devices, such as implants, that would be better tolerated by the body. The material could accommodate industrial design requiring strength and flexibility.

Schniepp said it's not only possible, but desirable to make commodity products. People cut down untold number of trees, and use their fibers to make paper, but the spider silk research could potentially offer a higher-performing and Earth-friendlier material.

Many products we use and dispose of frequently, such as drink bottles and pens, are petroleum-based, and create waste that isn't readily biodegradable. Plastic is a technology that has been developed and optimized over decades and is cheap.

"Right now, we're making water bottles out of plastic and then they become a problem," Schniepp said. "There's no reason you couldn't make this out of a protein material, like silk. Then you could drink your bottle and at the end you could eat the bottle."

Schniepp said that acceptance of newer materials would depend on how willing people are to accept the cost.

But Schniepp doesn't think it will be decades before this synthesized material is integrated into our lives. It could be under ten years, he said. Already there are three firms — one in the United States and two abroad — working on bringing this technology to market.

Schniepp would like his team's research to be used to grow the next generation of materials that is more benign, sustainable and can be more easily integrated into the living ecosystem around us.

"We don't have to resort to petroleum and steel if we want to build exciting things," he said. "If you just step out of your house on your lawn, there are super high-tech things going on."

Ben Swenson, ben.swenson05@gmail.com