Harnessing The Power of Spider Silk

Look beyond its foreboding red hourglass belly. The silk of the black widow is strong and supple. It is key to the spider’s successful existence—and it holds answers to enhancing our own.

In Biology Professor Craig Vierra’s lab, an intricate web connects black widows and the Pacific students who are helping conduct groundbreaking research to untwine the secrets of the spiders’ silks.

The venomous arachnids produce a silk that is five times stronger than steel of the same diameter, a fiber so resilient and adaptable that it can often withstand a swing from a broom handle. And it could have potential uses for the military, medical fields and the airline industry, among others.

The ability to potentially produce tougher tires and medical sutures, or lighter (yet just as strong) bulletproof vests and aircraft bodies, is found in a unique protein in the spider’s silk.

Eventually, Vierra’s lab aims to make the black widow silk a renewable resource for producing materials that may change how we engineer the future.

The Spider

Its web may not be as beautiful as the spiral wheels spun by an orb weaver (think of Charlotte in Charlotte’s Web), but the black widow is a highly evolved, remarkably successful workhorse of a spider.

The female black widow creates a diverse set of silks—seven different types, all serving a different purpose. The strands produced to protect her eggs are very dense, the silk to wrap prey is extremely efficient, and her strong, irregular tangle of a web is designed for optimal prey capture.

In the 200 million years of its existence, the black widow is at the height of spider evolution.

The Lab

The Pacific team seeks to identify the qualities of the proteins contained in black widow silk in hopes of eventually recreating it synthetically in large quantities—something the researchers have been able to accomplish only on a small level thus far.
“We’re working on fusing what we’ve learned here and expanding the procedure en masse,” Vierra said in Science Daily, which was reporting on an article by Pacific researchers published in the Journal of Visualized Experiments (JoVE), a video journal.

While scientists have been able to reproduce spider silk with integrity similar to that of the natural fibers for some time, they have had difficulty replicating a spider’s “post-spin” techniques, which increases the silk’s flexibility and strength.

Vierra and his lab have developed a technique to pull and stretch synthetic threads after they’re spun, to mimic the spider’s actions after spinning. By using a mechanical actuator, fibers can be stretched to a specified length, according to Science Daily.

“Before this procedure, there was a tremendous amount of variation in synthetic fibers,” Vierra said.

The methods discovered by the Pacific researchers will advance the process of producing synthetic spider silk and lead to higher quality fibers that surpass natural spider silks, according to the article.

Kristin Kohler ’04, a former student who is now a visiting assistant professor in the Department of Biological Sciences, has woven a strong foundation for herself in Vierra’s lab.

“I was one of the first sets of students who started on the research. We were cloning black widow genes, and we had a hard time isolating some of the genes, as they can look so similar. Other spiders had been cloned before, but this was the first time cloning black widows.”

Kohler worked for most of her undergraduate years in the silk spinning lab.

“As an undergrad, I earned a good foundation for research. During my time at Pacific, I published three papers. You can’t get that kind of exposure in other undergraduate schools. So when I applied for my PhD, I got into all the schools I applied to. I chose Yale.”

— Marnie Santoyo and Katie E. Ismael