Butterflies could hold key to probes that repair genes

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New discoveries about how butterflies feed could help engineers develop tiny probes that siphon liquid out of single cells for a wide range of medical tests and treatments, according to Clemson University researchers.

The National Science Foundation recently awarded the project $696,514. It was the foundation's third grant to the project, bringing the total since 2009 to more than $3 million.

butterflyThe research has brought together Clemson's materials scientists and biologists who have been focusing on the proboscis, the mouthpart that many insects used for feeding.

For materials scientists, the goal is to develop what they call "fiber-based fluidic devices," among them probes that could eventually allow doctors to pluck a single defective gene out of a cell and replace it with a good one, said Konstantin Kornev, a Clemson materials physics professor. "If someone were programmed to have an illness, it would be eliminated," he said.

Researchers recently published some of their findings about the butterfly proboscis in *The Journal of Experimental Biology*.

They are now advancing to a new phase in their studies. Much remains unknown about how insects use tiny pores and channels in the proboscis to sample and handle fluid.

"It's like the proverbial magic well," said Clemson entomology professor Peter Adler. "The more we learn about the butterfly proboscis, the more it has for us to learn about it."

Kornev said he was attracted to butterflies for their ability to draw various kinds of liquids.

"It can be very thick like nectar and honey or very thin like water," he said. "They do that easily. That's a challenge for engineers."

Researchers want the probe to be able to take fluid out of a single cell, which is 10 times smaller than the diameter of a human hair, Kornev said. The probe also will need to differentiate between different types of fluids, he said.

The technology could be used for medical devices, nanobioreactors that make complex materials and flying "micro-air vehicles" the size of an insect.

"It opens up a huge number of applications," Kornev said. "We are actively seeking collaboration with cell biologists, medical doctors and other professionals who might find this research exciting and helpful in their applications."

The study also is breaking new ground in biology. While scientists had a fundamental idea of how butterflies feed, it was less complete than it is now, Adler said.

Scientists have long known that butterflies use the proboscis to suck up fluid, similar to how humans use a drinking straw, Adler said. But the study found that the butterfly proboscis also acts as a sponge, he said.

"It's a dual mechanism," Adler said. "As they move the proboscis

around, it can help sponge up the liquid and then facilitate the delivery of the liquid so that it can then be sucked up."

As part of the study, researchers observed butterflies on flowers at the Cherry Farm Insectary just south of the main campus on the shore of Hartwell Lake. Butterflies were raised in the lab and recorded on video as they fed.

Researchers are turning their attention to smaller insects, such as flies, moths and mosquitoes, but the focus will remain on the proboscis.

In the next phase of the study, researchers would like to understand how the proboscis forms.

Larvae enter the pupa without a proboscis and emerge as a butterfly with one. Understanding what happens in the pupa could help develop the probes, Adler said.

Another challenge is figuring out how to keep the probe from getting covered with organic material when it's inserted into the body, he said.

That's why researchers are beginning to turn their focus to an insect almost everyone else shoos away.

"It seems the flies are able to pierce an animal's tissue, take up the blood and not get the proboscis gummed up and covered with bacteria," Adler said.

Tanju Karanfil, associate dean of research and graduate studies in the College of Engineering and Science, said the study has underscored the importance of breaking down silos that separate researchers from different departments so they can work for the common good.

"The most interesting work happens at the intersection of disciplines," he said. "In this case, biologists and engineers have come together with different perspectives to answer common questions.

"Their results are encouraging, and I look forward to seeing what they discover next."

Provided by Clemson University