Insect Catcher Lightens The Load For Researchers Battling Mosquito-Borne Illnesses

Emory University

The members of a research team from the Department of Environmental Studies at Emory University had one goal in mind when they began a project in Atlanta. They wanted to determine how the West Nile virus was transmitted by mosquitoes in an urban environment. Little did they know they would end up becoming known worldwide as inventors of the ProkoPack mosquito aspirator, a novel, inexpensive and efficient way to monitor adult mosquitoes and the deadly diseases they carry world-wide.

Their work with this tiny insect is no small matter. According to the World Health Organization, each year some 500 million people are infected with mosquito-borne illnesses: dengue, malaria, yellow fever and various forms of encephalitis, including West Nile virus. More than 2.5 million die, many of them young children. Mosquito infestations can be particularly troublesome in the wake of natural disasters such as floods or earthquakes — environments in which the tiny pests thrive and plaque victims during times of stress while hindering recovery efforts.

Therefore, monitoring mosquitoes is a crucial, life-saving step in the battle against mosquito-borne illnesses.

Enter the Emory research team. In 2008, Emory's Gonzalo Vazquez-Prokopec, Ph.D., a postdoctoral fellow working with Uriel Kitron, Ph.D., MPH, and chair of Emory's Department of Environmental Studies, set out to find if mosquitoes that harbor West Nile virus were overwintering — or hibernating — in the ceilings of 15-feet-high Atlanta sewer tunnels. However, they knew before they even began that reaching the mosquitoes was going to pose a challenge: The gold standard device for collecting resting mosquitoes for research and disease-monitoring purposes, the Centers for Disease Control and Prevention backpack aspirator (CDC-BP), had only a 6-foot reach.

Developed in the mid-1980s, the main principle behind the CDC device is to use air suction similar to a vacuum cleaner to collect mosquitoes that are resting in various habitats, including in homes' walls and under beds. CDC aspirators are commonly used by researchers and public health technicians to collect certain mosquito species inside houses and determine their numbers and potential infection with disease-causing pathogens.

Challenge Was to Remove the Bulk

In addition to not providing the correct reach, the CDC-BP, which resembles the bulky backpacks used in the 1980s by the Ghostbusters characters, weighs about 26 pounds. "I kept thinking, 'Why do I need a heavy motor on my back when I need to get suction to go to the ceiling?' That was the spark — we didn't need to go so heavy," says Vazquez-Prokopec.

"It's not like we woke up one day and said 'Let's invent a mosquito aspirator,'" says Vazquez-Prokopec. "It grew out of our needs during field research."

The research team, with technical support from William Galvin (an undergraduate student at Emory), began the design process by looking for the perfect lightweight motor. Using lab startup funds, they made numerous trips to local hardware stores to purchase and test different varieties of battery-powered motors to find the one that would provide just enough suction power to capture the mosquitoes, but keep them alive for analysis.

After deciding on the motor, co-inventor Kitron says their next concern was focusing on parts that could be found in a developing country. Kitron and Vazquez-Prokopec wanted the device to be cheap, easy to fix and simple to use. They found a painter's extension pole to give the device the height they needed and attached a plastic container covered by a wire screen to the battery-powered motor using a plumbing pipe coupler. The resulting device weighs 2 pounds and is easily maneuvered by one person. "And, you don't have to be taught how to use it," notes Kitron.

Collecting More Mosquitoes

In addition to reaching higher into ceilings and upper foliage, the "ProkoPack collects more mosquitoes than the CDC-BP," says Vazquez-Prokopec. "Because it can reach into locations where engorged females rest after a blood meal — such as under beds — more of the collected specimens are engorged with blood, so we can figure out in a lab where they are feeding from and whether or not they are infected," says Vazquez-Prokopec. The ProkoPack "has broad potential, not only for getting more accurate counts of mosquito populations, but for better understanding mosquito ecology."

For decades, public health officials in developing nations have relied on low-tech and low-price methods to conduct mosquito surveillance. One of the most popular methods is to spray the inside of a home with insecticide, and gather all the bugs that fall to the ground. Not only is the procedure time-consuming, but many of the mosquitoes are dead when they hit the ground.The ProkoPack takes only 10 minutes to make a collection and most of the mosquitoes are

caught alive, allowing for better preservation of samples for future processing. Vazquez-Prokopec says better monitoring of mosquito populations makes it easier to take action against them.

The ProkoPack has outperformed the CDC-BP in field tests in underground tunnels in Atlanta and in indoor collections in Iquitos, Peru, during a dengue fever study. It was during the Peru field study that the Emory team named the device. “We wanted a catchy name, not just ‘the mosquito aspirator,’” says Vazquez-Prokopec. “We came up with a combination of my last name and ‘pack.’ As the inventor, I am very proud of the name ProkoPack.”

Kitron is most pleased with how the ProkoPack has been embraced by researchers. The key to exploring mosquito-borne diseases, he says, is having a good understanding of the risk andthe mosquito population in a particular area. Fellow researchersin Africa have embraced this alternative to the time-consumingspraying of houses, which requires more equipment and moretechnicians and is inconvenient for residents who must leavetheir homes. Because data can be collected by one person inonly 10 minutes, it is much easier to target problem houses.

The device is currently being tested in different epidemiological settings including: Coastal Kenya, Zambia and Tanzania for malaria vectors; in Australia, Mexico, Argentina, Thailand and Peru for dengue fever vectors; and in Italy for West Nile virus.

Many institutions in the United States have purchased Proko- Packs to use in local settings. Public health offices in Virginia and Illinois are using the units to monitor West Nile virus mosquito vectors. Researches in Michigan, Illinois and Indiana have purchased units to perform research on different mosquito vectors, and the U.S. Department of Agriculture is interested in purchasing units to test with agricultural pests.

ProkoPack More Affordable

Emory University is selling the ProkoPack for $150 to cover production costs. By comparison, the CDC-BP sells anywhere from $500 to $750. Because of the affordable price and portability, more developing countries will be able to afford the ProkoPack, says Vazquez-Prokopec. “I come from a developing country, Argentina, so I know what it means to be in a place where you can’t get something because of money,” he adds. “We are making this technology available for people in places most in need.

“There is a great need for effective and affordable mosquito sampling methods,” he continues. “Use of the ProkoPack can increase the coverage area and the quality of data collected. Ultimately, we hope it can help us develop better intervention strategies that are more effective than what we currently have.”

Focusing on Use in Developing Countries

That the device is a more affordable alternative to mosquito collection is something that the university supports as well. The ProkoPack is a natural fit for Emory University’s Office of Technology Transfer (OTT) licensing principles that focus on humanitarian use, says Chris Paschall, Ph.D., CLP, and licensing associate for the OTT. “Our license agreements include provisions that a device or drug has to be readily available to populations that otherwise could not be reached.”

Paschall, who helped develop the licensing strategy and payment procedure, says this has been a fun project to manage because so many researchers are excited about collecting mosquito samples with a device that is lightweight and easy to use, especially in hot and muggy tropical climates. “We have been thrilled to make available a device that is inexpensive and works better than anything else on the market and that has that lowered the bar for entry for countries around the globe,” he says. “It’s very exciting to be a part of that.”

The OTT staff contemplated two different licensing strategies to commercialize the ProkoPack. The first idea was to license the device exclusively to an existing company for manufacturing, marketing, sales and distribution. The downside of that strategy was that the company would charge a fee for the services, adding to the cost of the device.

"If the device was too expensive, it would be out of reach for many of the countries who need it most," says Paschall.

To keep costs down, the OTT decided to employ a nonexclusive licensing strategy and manufacture and distribute the device directly from Emory.

> *The device is sold at cost and users sign a click-through-type license and payment agreement. By utilizing this strategy, "the device is cheap enough for nearly anyone in the world, and we can distribute it very quickly," says Paschall.*

After the earthquake in Haiti, Vazquez-Prokopec sent three ProkoPacks to the CDC for collection of mosquitoes due to concern that conditions would be ripe for transmission of dengue fever. Co-inventor Kitron says that's exactly the type of activity that fits with the Department of Environmental Studies' mission to be a leader in global health. In addition, the scientists published simple instructions on how to make the ProkoPack in the Journal of Medical Entomology.

Data Useful for Developing Mosquito Intervention Methods

"The ProkoPack is extremely effective in showing public health officials how malaria vectors are distributed between houses and even within a house," says Kitron, "which in turn will help them to reduce the transmission of the disease by collecting data they need to target mosquito intervention."

Because mosquitoes and other vectors are such a worldwide public health issue, the device is being tested by scientific colleagues from multiple institutions including the CDC, Johns Hopkins Bloomberg School of Public Health in Baltimore, Md.; University of Torino in Torino, Italy; and James Cook University in Townsville, Queensland, Australia. Part of the licensing agreement requires the scientists to share feedback on the device, which Vazquez-Prokopec says his research team will welcome to make improvements.

Kitron hopes the simplicity and ease of the ProkoPack will lead public health agencies to not only address mosquito-borne diseases before and during an outbreak, but also after an outbreak to see how the control measures they applied are working.

"We did not cure a mosquito-borne disease, but we opened new doors in terms of mosquito research and surveillance at an affordable price," says Vazquez-Prokopec. "We moved from building a tool to get to the ceiling to designing a tool that can be used worldwide to measure other vectors more effectively than traditional methods."

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