

## Navy Entomologists Focus on Mosquitoes

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In humid, climate controlled CDC labs, two US Navy entomologists test mosquito susceptibility to different types and doses of insecticides. They are guest researchers with the Center for Global Health, Division of Parasitic Diseases and Malaria (DPDM), Entomology Branch.

“Some service members in the Navy don’t know we have entomologists,” said David Hoel, PhD (CDR, US Navy), an entomologist with the United States Navy, Medical Service Corps for 17 years. As Department of Defense (DoD) scientists, their mission is to research products, technologies, and techniques that protect troops from severe and sometimes fatal insect-borne diseases. “Up through the Vietnam War, we lost far more personnel to insect-borne diseases and other transmittable and epidemic diseases than we did to enemy action,” said Hoel who has provided his expertise and knowledge to US and overseas partners. He arrived to CDC headquarters in Atlanta, GA, September 2011 for a three-year assignment.

“The DoD has little tolerance for our troops coming down with vector-borne diseases; thus it is our job to provide them with recommendations based on the best collaborative research,” said James Dunford, PhD (LT, US Navy) who will work at CDC until 2013.

Navy entomologists also seek feedback from the troops in an attempt to develop better products than those already in the stock system. “The DEET cream repellent that we use now in the DoD is thick and sticky, and we are seeing that when people deploy to hot desert or humid environments they often don’t apply this repellent because of the greasy feeling it imparts to the user – although it lasts a long time (up to 9 hours) and water does not wash it off easily. However, people don’t like it, and as a result, it is not used to its fullest extent. Therefore, we evaluate other effective DEET formulations and test candidate repellents in hopes of finding better formulations and alternatives that will have wide acceptance and provide comparable protection,” said Hoel.

“Military entomologists have much more of an applied background because many have been deployed with the troops and have had to control these insects on a daily basis. They are doing actual spraying, selecting insecticides, collecting mosquitoes in the field, and they also do a lot of humanitarian work,” said Robert Wirtz, PhD, entomology branch chief and their CDC supervisor.

### Global Collaboration

CDC complements the President’s Malaria Initiative (PMI), an interagency initiative led by USAID to cut malaria deaths in half in sub-Saharan Africa. Hoel is PMI’s entomologist coordinator for Uganda and Liberia. “PMI has a lot to offer military entomologists in that we get to see what public health control strategies and methodologies are used by CDC, USAID, spray contractors, and NGOs firsthand in the fight against malaria. Opportunities to learn new monitoring and evaluation techniques benefit the military, as we share what we learn with our peers. Likewise, we use our past deployment experience to help with field



Dunford and Hoel in a CDC insectaria room that breeds *Anopheles Gambiae*, a vector that in sub-Saharan Africa is the main malaria transmitter. *Photo by María-Belén Moran*



Dunford demonstrates how to treat and prepare bottles that will later be used to test insecticides. *Photo by María-Belén Moran*

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studies and in training host nation Ministry of Health personnel. It's a win-win situation for both teams."

Dunford joined the Navy while working on his PhD at the University of Florida. He said that Hoel has been his mentor since he joined Navy Entomology. "I met David, as I addressed him back then, while I was working on my PhD in Entomology and teaching a class that he took when he arrived at UF to do his PhD. Back then I was his instructor; now I address him as 'Sir,'" said Dunford. "The US Navy only has 35 active duty entomologists, so it is rare to be working with him one-on-one for a couple of years. And by the way, he did get an A in my course."



Hoel holds a bucket of *Anopheles Gambiae*, a vector that in sub-Saharan Africa is the main malaria transmitter. Photo by María-Belén Moran

Their positions at CDC were driven by the DoD's [Deployed War-Fighter Protection Program \(DWFP\)](#), a research initiative created in 2004 to develop and validate methods to protect military personnel from threats posed by disease-carrying insects. At CDC they are primarily working with the Malaria Branch.

"This has been a fabulous program for us. We have had active duty military entomologists stationed in the division from all three military branches. Initially it was restricted to one year but under the DWFP it has been extended," said Wirtz. "When they leave CDC we keep in touch. They take what they learn here and put it into practice domestically and internationally, and they share with us what they learn."

On March 5<sup>th</sup> Hoel and Dunford will give a presentation about Navy Entomology and the DWFP at CDC's headquarters as part of DPDM's spring seminar series.

#### Year-Round Mosquito Season

"It is mosquito season year-round for us in the Navy; we have people deployed all around the world," said Hoel. "We are always looking for better, more effective products." At CDC they are currently testing an environmentally friendly insecticide made out of fatty acids that a company brought here for testing.

"It is a potential novel mode-of-action insecticide consisting of food grade, carbon chain fatty acids that can kill mosquitoes on contact. This could provide us a new product that is very safe to control mosquito populations" said Dunford. "And this is one of the few compounds that may fall under the category of insecticide and repellent," added Hoel. These compounds are being tested for efficacy against mosquitoes, using a bottle assay designed by CDC entomologist William Brogdon.

"This CDC bottle bioassay is easy to use and the materials are fairly inexpensive," said Hoel. "Working with the PMI in Africa, I've trained Ministry of Health mosquito control personnel on how to run this assay. That is one of the ideas behind us being at CDC—we learn the latest laboratory techniques, cutting edge technology, and new methods and materials that we take back to Africa, South America, and South East Asia in support of PMI."

"With Dr. Brogdon's test, you use standard size bottles and treat the inside surface with one milliliter of technical grade insecticide mixed with acetone, roll the bottle to make sure the inside surface is covered with the solution, and the next day you are ready to run the test. It's convenient and being used in the field," said Dunford while demonstrating how the assay is run. "You can take the assay to the field and test a particular insecticide on a wild population of mosquitoes to help identify resistance."



Dunford teaching basic entomology to a group of students in a town located in central Afghanistan. Photo Courtesy of Jim Dunford

"And that is very important because we need to know if the management strategies (insecticides) we are spending millions of dollars on trying to save people's lives actually work. The vast majority of malaria deaths are in Africa and in the last year or two there has been an actual decrease in the number of malaria deaths. We think that is in large part due to the PMI program, but there could be some weather

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change phenomena going on as well. WHO estimated 655,000 deaths last year, which is down from 1.1 to 1.2 million several years before. We believe that this program has had an impact,” said Hoel.

## Dog Days of Summer

Malaria or a disease resembling malaria has been noted for more than 4,000 years. It is a mosquito-borne disease caused by a parasite that produces fever, chills, and flu-like illness. Left untreated, people may develop severe complications and die. In the US, endemic malaria was considered eliminated by 1951.

“We feel that malaria is a disease that can be stopped, albeit very slowly, as it takes tremendous effort and financing from public health and donor agencies,” said Hoel. “There were as many as one million cases of malaria in the US annually during the 1930s, especially in the South where we had several good mosquito vectors. Infected people were too sick, tired and weak to do much of anything, and the presence of malaria throughout the South hampered economic development much as it does in Africa today.” He continued, “My grandfather told me that the term 'dog days of summer' was tied to malaria in the rural South, where he grew up.” The name of the disease comes from the Italians, meaning 'bad air' or mal'aria. Romans linked malaria with harvest time, also the time when Sirius, the brightest night star, was dominant during the hottest days of the summer. Sirius is part of the Canis Major (Big Dog) constellation. Malaria was also linked to the swampy areas around ancient Rome where malaria was common and was associated by the Romans with the “bad air” arising from those swamps. People didn't yet know that the disease was dependent on mosquito populations. Even today there are countries where vector-borne diseases are endemic and where communities are not familiar with basic mosquito prevention.

“In Afghanistan I was the entomologist with a unit that traveled to villages to teach basic medical entomology and mosquito control.” said Dunford. “We taught brief courses to local healthcare providers and village elders on how to control mosquito populations, using practical means such as eliminating standing water. In some areas, villagers did not know where mosquitoes came from, and were interested to learn that their immature stages lived in water.”

The PMI supports various types of malaria control methods. One is spraying insecticides on the walls inside of houses. And because mosquitoes become resistant to pesticides, it is necessary to develop and test new ones.

“In Africa insecticides are being sprayed on the walls and the roofs of huts, houses, and that's one of the primary means of controlling mosquitoes and preventing malaria. The concept is to treat the inside of the house because mosquitoes come inside during night and in the early morning to feed when people are asleep. One of the first things that a mosquito does after entering a house is land on a surface and rest. If that surface is a wall or bed net with insecticide on it, there is a good chance that the mosquito will pick up a lethal dose and die before it gets a chance to infect a person,” said Hoel. “However, we have to keep changing our strategies and technologies because mosquitoes adjust, evolve, and can develop resistance to chemicals pretty fast.”

“And that is exactly why we are here, to learn from world class scientists on how to better control disease-transmitting insects and related groups, and use what we learn at CDC to better service deployed troops and countries in need of public health expertise,” said Dunford.

This *Inside Story* by María-Belén Moran.

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