

MEDICAL ENTOMOLOGY IN THE UNITED STATES DEPARTMENT OF DEFENSE: CHALLENGING AND REWARDING

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It may surprise you to learn that the United States Department of Defense (DoD) maintains a highly-trained cadre of about 115 active duty uniformed entomologists. Approximate numbers across the services are Army-65, Navy-35 and Air Force-15. Although the primary focus is on medical entomology and pest management, DoD entomologists are involved in a wide variety of interesting and at times unique activities, many of which will be highlighted in this article.

Humanitarian Assistance

Earthquakes, storms, floods, and other natural disasters often create conditions that can result in disease outbreaks and dramatic increases in nuisance pests. The recent earthquake in Haiti is a prime example. Military entomology has been involved with the US military's humanitarian response following natural disasters or other emergencies for over 50 years. US governmental agencies have long recognized the uniqueness of the military entomology community, especially the capability to respond rapidly anywhere in the world. Military entomologists provide equipment and expertise for disease surveillance, vector and rodent control, and assist in the reestablishment of normal living conditions. For example, following the devastating tsunami in Southeast Asia in 2004, military entomologists were dispatched to Indonesia to aid local authorities in preventing insect-borne disease outbreaks. Military entomologists were also sent to the US Gulf Coast

region to provide disease vector surveillance and control assistance following Hurricane Katrina in 2005. From providing vector control during the great Kansas City flood of 1951, mosquito control prior to President Truman's dedication of Everglades National Park, vector control during relocation operations for Vietnamese and Haitian refugees, to mosquito surveillance following the historic Midwest floods of 1993, the unique expertise of military entomologists has been instrumental in controlling insect-borne disease outbreaks, nuisance pests and relieving human suffering during disaster situations.

Control of Insects in Deployment/Contingency

The effect of insect-transmitted diseases on military operations has been well documented. For example, loss of troops from louse-borne typhus was an important reason for Napoleon's retreat from Moscow in 1812. During the US Civil War, malaria was rampant in both Union and Confederate forces, and typhus and malaria affected armies fighting in Europe during World War I. During World War II, the US recognized the need for uniformed entomologists in combat areas, especially in the South Pacific. An estimated 85% of US forces serving in combat areas contracted malaria. This led General Douglas MacArthur to conclude: *"This will be a long war, if for every division I have fighting the enemy, I must count on a second division in the hospital with malaria and a third division convalescing from this debilitating disease."* During World War II, in addition to the South Pacific, military entomologists served in Europe, China, North Africa, the Caribbean and Central America.

Since World War II, military entomologists have been a part of every major operation and contingency with which the US military has been involved. Military entomologists were on the ground in Korea, Vietnam, supporting UN peacekeeping forces in Beirut, in Saudi Arabia during operations Desert Shield/Desert Storm, in Somalia, and most recently in Iraq and Afghanistan, supporting Operations Iraqi Freedom and Enduring Freedom. In the Middle East, where malaria is endemic, another little known, but insidious, blood-sucking fly known as the "sand fly" (*Phlebotomus* spp.) has become well known to personnel deployed to the region. Sand flies can transmit a parasite that causes leishmaniasis, which in its various forms can cause disfiguring lesions and even death. Military entomologists deployed to Afghanistan and Iraq are developing surveillance and control techniques to combat sand

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Figure 1. A U.S. Air Force Reserve C-130 Hercules from the 910th Airlift Wing at Youngstown Air Reserve Station, Ohio, sprays Dibrom, a pesticide approved by the U.S. Environmental Protection Agency, over New Orleans on Sept. 13 2005. (U.S. Air Force photo by Staff Sgt. Jacob N. Bailey)

flies and prevent leishmaniasis transmission. Other threats, such as scorpions, snakes, feral dogs and camel spiders are found in areas of the Middle East, and military entomologists reduce the impact of these creatures on the health of deployed personnel.

Exercise Support

Military entomologists regularly participate in military operations and exercises around the world. From providing medical intelligence to field commanders to conducting disease vector and pest surveillance operations, military entomologists provide critical expertise in lessening the impact of disease and nuisance pests during military exercises. For example, entomologists from the US Navy Entomology Center of Excellence in Jacksonville, Florida recently provided operational support to the Florida National Guard's 53rd Brigade Combat Team that was conducting field training prior to the Brigade's deployment to Afghanistan. The Brigade conducted training at Florida's Camp Blanding Joint Training Center, a large field site located in North-central Florida. This field site has large populations of ticks and mosquitoes, and entomologists were able to lessen the impact of these arthropods during the Brigade's extensive pre-deployment training.

Military entomologists typically play an important role in these types of exercises, especially those conducted in areas of the world with endemic vector-borne disease. Cobra Gold, a large multi-service exercise conducted annually in Thailand, where malaria and dengue are endemic, has included military entomologists as part of preventive medicine teams. In March 1997, a large military exercise was held in Northeastern Australia, in an area endemic for mosquito-borne viruses. The exercise, "Tandem Thrust" included approximately 28,000 military personnel and was conducted during the height of the mosquito-borne virus transmission season. The US Navy sent a 10-person "deployable public health laboratory" to participate, and entomologists concentrated on collecting mosquitoes within the large training area for virus isolation

studies. During the exercise, there were several cases of the debilitating Ross River virus disease in troops, and 5 virus isolates were identified from mosquitoes. Based on this real-time threat assessment, military entomologists convinced field commanders to enforce aggressive mosquito protection measures, such as use of repellents and proper wear of the field uniforms that most likely reduced the disease burden.

Quarantine Issues

Historically, military entomologists have played a significant role in reducing the effects of insects and other organisms on the health and safety of the United States and other nations by conducting agricultural inspections and equipment wash-downs. All weapons, vehicles and equipment returning from service overseas must be washed and certified free of exotic pests, including plants, prior to its return to US soil. Following a complete washdown of these items, military entomologists often serve as "certifying officials" that inspect and verify that items returning are pest free. These operations can be quite extensive, involving thousands of items. For example, after the Gulf War, more than 50,000 pieces of equipment were washed and inspected before being returned to their bases on American soil.

Military entomologists may also be called on to inspect equipment going into countries where US military forces go to train and conduct exercises. In 1997, as the US Marines were preparing for a large exercise in Australia, Australian agricultural quarantine inspectors were sent to Okinawa, Japan to inspect all of the vehicles and equipment that would be used. A US military entomologist accompanied the inspectors to ensure that the equipment and vehicles met the stringent Australian inspection requirements. In another example of the importance of meeting agricultural quarantine regulations, the USS Blue Ridge, the command ship of the US Seventh Fleet, was stopped in Townsville, Australia during this same exercise, as the ship had passed through an area inhabited by the Asian gypsy moth, a vicious pest of trees that is not found in



Figure 2. Military Entomologist applying thermal fog treatment to a bunker on Camp Babylon, Iraq in 2004. (Photo by Chief Hospital Corpsman Renato Ngo)



Figure 3. US Navy preventive medicine personnel calibrate an ultra low volume sprayer for mosquito control during a training exercise. (Photo credit: LT Jennifer Remmers, United States Navy)



Figure 4. US Navy Entomologist LTJG Jeffrey Hertz provides vector identification training to vector control personnel in El Salvador

Australia. It was not until a US military entomologist inspected the ship, and certified that it was free of the pest, that Australian officials allowed it to proceed south to the exercise area.

Venomous Animals

Venomous animals in distant lands are always a concern for deploying troops. Misinformation, coupled with pre-deployment hype, can result in visions of man-eating spiders, 10-foot long scorpions and snakes capable of inflicting a painful death simply by wagging their tails! Frequently, however, these fears are not unfounded as a US Marine found during Operation Desert Storm. While he slept, he was attacked by a camel spider, with a resultant wound that took ten stitches to close.

By far, snakes are the most feared creatures during deployments. Imagine the alarm when US military personnel taking part in Exercise Tandem Thrust 1997 in Australia learned that maneuvers would take place in a training area that was home to 6 of the world's 10 most venomous species of snakes. Although snake bites and venomous stings are fairly rare events during deployments, the concern is very real and must continually be addressed through education and discipline.

Medical Assistance and Capacity Building

Military entomologists have also been involved in unique missions that not only provide aid to other countries, but help build and strengthen host nation's insect and vector control programs. In 2003, the Republic of Palau requested US assistance in conducting surveillance for *Aedes aegypti*, a primary vector of dengue viruses. A team of 12 military public health personnel, including two entomologists, spent two weeks conducting an extensive survey for the mosquito throughout the islands of Palau, and provided in depth mosquito surveillance and control training for the government's environmental health personnel. The team also provided a variety of surveillance and control equipment that augmented what the vector control personnel already had and improved their

ability to conduct future mosquito surveillance and control operations.

Within the last few years, the US military has been involved in several humanitarian assistance/capacity building missions that are part of the US Defense Department's strategy to promote "soft power" in many regions of the world. The missions have involved sending public health and medical personnel that are embarked on US Navy ships to areas of Central and South America and the Western Pacific. Military entomologists are part of these teams and they focus their efforts on providing vector-borne disease surveillance and control training for host nation personnel. For the past three years, these missions have included "Continuing Promise" in Central and South America where public health and medical teams visited Colombia, Peru, Nicaragua, El Salvador and other countries. In the Western Pacific, "Pacific Partnership" included visits to places such as the Solomon Islands, Samoa, Tonga, Indonesia and other countries in Southeast Asia and Oceania. These missions not only provide assistance to the countries that are visited, but result in exceptional real-world training to military entomologists in controlling vector-borne diseases.

Medical Research and Development

The US military has been in a long and ongoing war that predates, by far, the Global War on Terrorism. It is a war that has resulted in countless casualties and immeasurable misery; the war against arthropods and the diseases they transmit. Did you know that of all the infectious diseases considered to be militarily important, nearly two-thirds are transmitted by biting arthropods? By developing new technologies and methodologies that prevent these natural agents of destruction from biting or coming into contact with humans, or by preventing the pathogens they transmit from developing into clinical disease, we can reduce the odds of forces succumbing to such debilitating diseases as malaria, dengue, chikungunya, Rift Valley fever, etc.

It is the mission of the US DoD's Military Infectious Diseases Research Program (MIDRP) to develop products



Figure 5. Vector-borne disease surveillance and control training provided to Nicaraguan Vector Control personnel during “Continuing Promise 2008”.

and technologies to protect US military personnel against naturally occurring infectious diseases via the development of US Food and Drug Administration (FDA) approved vaccines, drugs, and diagnostic assays and Environmental Protection Agency (EPA) approved arthropod control protection systems. This \$67M program is conducted by over 2,300 Army, Navy, Air Force and civilian personnel at US Army and Navy infectious diseases laboratories located in Egypt, Cambodia, Ghana, Kenya, Peru, Thailand and the US. This program is augmented by the DoD’s \$5M Deployed Warfighter Protection Program (DWFP). While the MIDRP also conducts research in preventing other infectious diseases not transmitted by arthropods, such as HIV and diarrhea, the DWFP specifically targets developing and fielding (1) new insecticides, to include discovering new active ingredients and reformulating existing insecticides; (2) new application technologies; and (3) new or improved personal protection systems.

Both of these programs also closely interact with the larger medical research and development community through sharing technology and by leveraging support from outside organizations and university partners. Examples include the National Institutes of Health (NIH), the US Department of Agriculture (USDA) and the US Agency for International Development (USAID); and nonprofit organizations such as the Bill and Melinda Gates Foundation and Medicines for Malaria Venture. Also, pharmaceutical companies and other industry partners are critical to success.

Medical Information/Disease Risk Assessments

Once military units learn they are to deploy to a foreign land, they work to address a wide range of issues that might negatively impact their ability to complete their mission. One area that is often of particular concern is infectious diseases. Prior to deployment, medical planners determine what diseases are present in that region; the risk to the force, and the potential for large-scale outbreaks that could negatively impact the

mission; and most importantly, how public health personnel can reduce or even eliminate that risk.

To develop these risk assessments, medical information (aka medical intelligence) is gathered from numerous sources. These include, but are not limited to, media reports, scientific literature, other governmental agencies, non-governmental agencies, and after-action reports from prior military missions. This information is then compiled and used to formulate risk assessments for those diseases likely to be encountered.

While such information received and distributed before deploying is important, it is often critical to have real-time data from the location or region where the unit will be operating. It is a primary responsibility of military entomologists and preventive medicine specialists to provide those data. This involves having “boots on the ground” where these individuals closely interact with local, regional and national public health authorities and conduct surveillance for potential disease vectors to determine abundance, prevalence of pathogens in the vectors as well as the diseases in the local human and animal populations. This type of data collection can occur at anytime, including before the unit actually deploys, but it is most often collected after the unit has arrived in the country and it often continues for as long as the unit is deployed. The collected information is then used to update the initial risk assessments. These on-site surveillance activities are an invaluable resource in not only identifying the risk of vector-borne diseases to deployed forces, but in also identifying ways to reduce or eliminate that risk. These activities are occurring every day in Iraq, Afghanistan, and wherever US Forces are deployed.

A number of organizations provide this medical intelligence and a primary example is the Defense Intelligence Agency’s (DIA) National Center for Medical Intelligence (NCMI) located at Fort Detrick, MD, USA. This center collects, evaluates, analyzes and interprets medical and environmental information that is used by medical planners. Other organizations such as the US Armed Forces Pest Management Board (AFPMB) in Silver Spring, MD provide complementary information that is more focused on medically important arthropods and other species of potential importance. Just one example is AFPMB’s Disease Vector Ecology Profiles (DVEPs). These provide summaries of the bionomics of disease vectors and data on hazardous animals and plants for individual countries or geographic regions. This information is unclassified and available at www.AFPMB.org.

Remaining Vigilant

The threat posed to deployed forces by arthropods, venomous animals and other vermin is very real. Morbidity and mortality from the bite of tiny insects can cripple the best trained armies in the world. Therefore, it is imperative that preventive medicine teams remain vigilant on a global basis. Military medical entomologists have a long and proud history of ‘serving those who serve’ and this will continue long into the future.

Disclaimer: The opinions and assertions contained herein are those of the authors and do not necessarily represent the views of the United States Department of Defense or the United States Navy. Mention of any commercial product does not necessarily constitute an endorsement.

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