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Species Diversity and Disease-Vectoring Capabilities of Mosquitoes Surrounding the Main Campus of Texas A&M University

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Edited by Van Adams

Abstract: Mosquito-borne diseases, such as malaria, account for many deaths throughout the world each year. It is therefore essential to become familiar with the species that vector these diseases, in order to take steps toward enhancing treatment and prevention. Additionally, several competent vectors of some of the deadliest mosquito-borne diseases are known to inhabit the United States. Due to its central location and favorable climate, the city of College Station is a good habitat for many species of mosquito. The goal of this study was centered on discovering which species are abundant in the highly populated areas where students who attend Texas A&M University live. Larvae were collected from small bodies of water in three of the most popular residential areas surrounding the campus. Some specimens were reared out to the adult stage for identification, while others were killed as larvae to be identified. It was found that each of the three collection sites held larvae of mosquitoes that are competent vectors of serious diseases. Species found include Anopheles quadrimaculatus (Say) (Diptera:Culicidae), Aedes triseriatus (Say) (Diptera:Culicidae), and Culex salinarius (Coquillett) (Diptera:Culicidae). Therefore, if the pathogens of these diseases were to arrive in College Station, many community members would be at risk of infection.

Keywords: Anopheles quadrimaculatus, Aedes triseriatus, Culex salinarius

The mosquito is the deadliest animal on Earth when one considers the number of deaths caused by the diseases they vector. With this in mind, the goal of this study was to determine which species of mosquito are present in the residential areas surrounding Texas A&M University, in order to ascertain for which mosquito-borne diseases students who attend the University may be at risk. Mosquitoes are taxonomically classified under the order Diptera – referring to true flies, suborder Nematocera, family Culicidae. While they are certainly not the only insect group that has the ability transmit life-threatening disease pathogens, they are arguably the most important. Depending on preference and evolutionary adaptation, mosquitoes either lay their eggs in permanent, shallow bodies of water or in areas that are prone to flood. Those that deposit eggs in permanent water sources can be referred to as permanent water species,

and those that deposit eggs in flood-prone areas can be referred to as floodwater species. It may also be noted that the eggs of floodwater species have an increased ability to resist desiccation. Once the eggs hatch, the resulting larvae must then live at the surface of the water so that they can breathe, either by means of an air siphon on their terminal segment, or, in the case of the genus Anopheles, by means of a breathing mechanism on their spiracular plate. Because of their intimate dependence on their environment, most mosquito larvae require warm temperatures for further development to occur. The larvae will develop in a series of stages known as instars, of which there are usually three to four. During these stages, the larvae will commonly feed on microorganisms in the water. After the fourth instar, mosquito larvae will develop into pupae, a non-feeding and highly mobile form. Following this, the adult will emerge from the pupal stage, undergo sclerotization of its exoskeleton, and begin seeking a host after an initial carbohydrate meal. The overall length of this life cycle largely depends on species (Durden and Mullen 2009).

Due to varying feeding preference with respect to time of day, location, and host availability, mosquitoes have varying inclinations toward particular hosts. It is important to understand these characteristics as they pertain to a given species, in order to effectively prevent contact between the vector and a potential host. One of the reasons a considerable amount of funding is dedicated to research in this field is that a significant number of mosquito species will feed on humans, whether by initial preference or opportunistic means. Therefore, a particularly important issue concerning mosquitoes as a group is their typically high competence to vector disease pathogens to their hosts. Examples of such diseases that can affect humans include varying forms of encephalitis, malaria, dengue and yellow fever, West Nile virus, and several types of filariasis, among many others. Certain species have coevolved with certain pathogens, and accordingly a specific species and/or genus of mosquito is generally closely associated with a specific type of pathogen. For example, Anopheles quadrimaculatus was historically the principal vector of malaria in the United States. This sort of connection between disease pathogens and vectors is representative of what is commonly seen. (Durden and Mullen 2009).

In addition to the ability to vector various pathogens, mosquitoes may also cause direct effects to those they feed on. Such effects may be in the form of general irritation to allergic reaction, to possible secondary infection resulting from excessive itching of bites.

Materials and Methods

Mosquito larvae were collected from three sites: north, south, and east of the Texas A&M University campus in College Station, Texas. Specifically, the northern location was a drainage ditch at the corner of Spruce Street and College Main, the southern location was Bee Creek in Brison Park, and the eastern location was a small pond in Wolf Pen Creek Park, near the intersection of

Dartmouth Street and Holleman Drive East (Figure 1). The habitats from which the specimens were collected were all of the permanent water type.

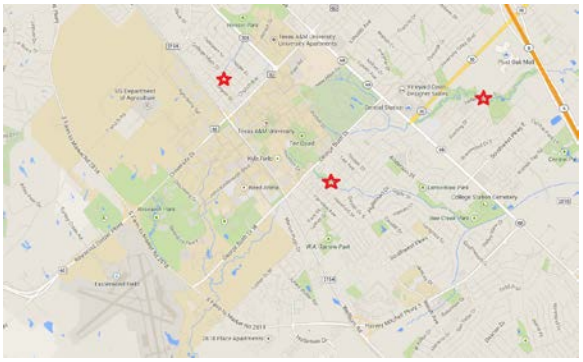

Figure 1. Map of collection sites

During the collection process, disposable plastic cups were used to scoop up the larvae from the surface of the water. Various larvae collected from the different sites were then reared to the adult stage using a dual-chambered container, constructed from two plastic bowls with lids (Tupperware Brands Corporation, Orlando, FL), a funnel (United States Plastic Corp., Lima, OH), and hot glue (FPC Corporation, Wauconda, IL) (Figure 2).

Figure 2. Adult rearing chamber

A dissecting microscope (National Optical Instruments Inc., Schertz, TX) was utilized to better visualize the specimens during identification. In order to properly identify the larvae, the use of a dichotomous key was implemented as well (Stojanovich and Pratt, 1966).

Results

At the northern location on March 28, 2014, three Anopheles quadrimaculatus larvae were collected, one of which was reared out to the adult stage. On April 5, 2014, six larvae were collected at the southern location, and the one particular larva that grew to be an adult was an Aedes triseriatus. The remaining five larvae consisted of three Anopheles quadrimaculatus and two Culex salinarius. Five larvae were collected from the eastern location on April 6, 2014, one of which was reared out to the adult stage and was identified as Aedes triseriatus. The other four were Culex salinarius (Figure 3). Several other recorded attempts to collect mosquito larvae resulted in failure. These included attempts made throughout the month of February, as well as during early March. Average weekly temperatures recorded in College Station corresponding to all possible collection dates can be found in Figure 4.

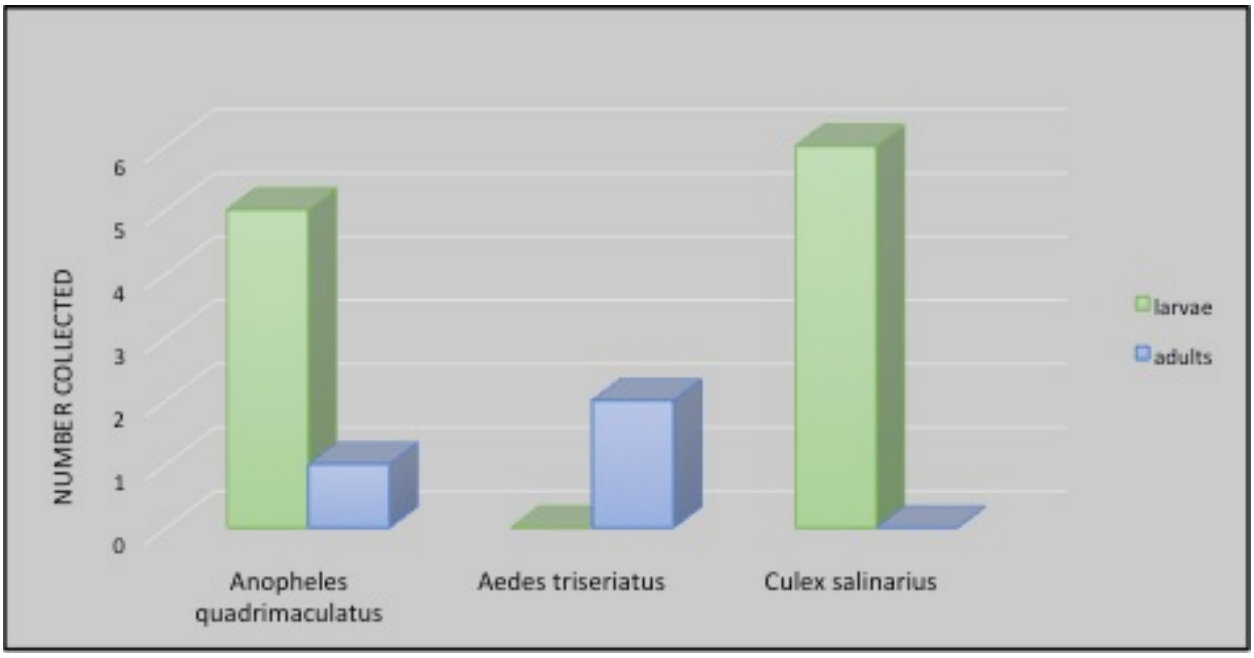

Figure 3. Total number of species of larvae and adult mosquitoes collected

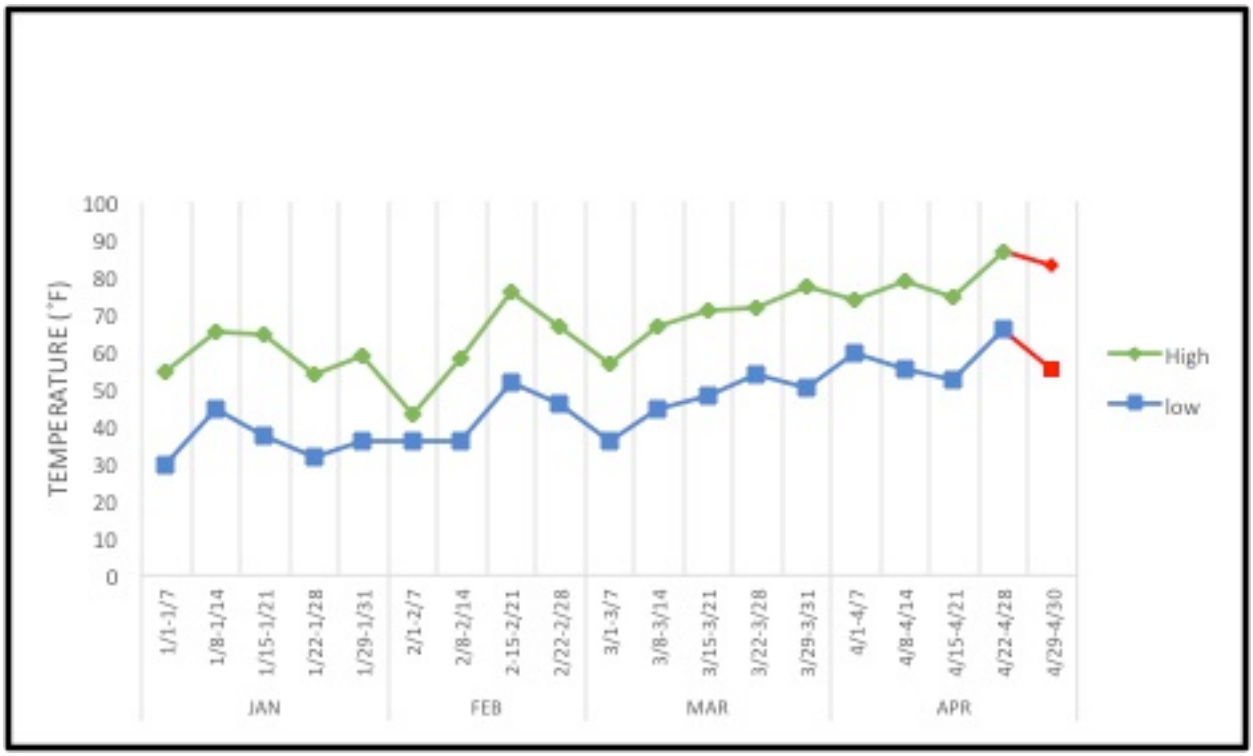

Figure 4. Weekly average temperatures of the College Station area from Jan. to April 2014

Figure 6. Number of *Varroa destructor* mites counted on 24-hour sticky board tests performed over time from 12 honey bee colonies located at the Riverside apiary and 12 honey bee colonies located at the Ash apiary from 17 October 2013 through 27 November 2013.

Discussion

As one can see from the data collected, three species of mosquito were encountered during the course of this experiment. These include *Anopheles quadrimaculatus*, *Aedes triseriatus*, and *Culex salinarius*, all of which are known to be found in Texas. The different species found suggest that the areas surrounding campus best accommodate standing water breeders. Due to the presence of larvae found in Brison Park, it may be suggested that several other parks around the area, many with their own ponds, are possible environments conducive to mosquito breeding.

When one scrutinizes the outdoor temperature patterns observed thus far this year, conclusions regarding a probable cause of the failed collection attempts early on in this experiment can be drawn (Figure 4). January and early February experienced temperatures that were generally too cool to support mosquito development. In mid to late February a rise in temperature that could have better permitted increased mosquito activity was observed. However, soon after this temperature peak there was a drop in temperature that could have killed any developing mosquito larvae. Therefore, it is appropriate to note that all the specimens collected for this experiment were found in late March to early April once conditions became more conducive to larval development.

The results of this study can be considered important and relevant to the students of Texas A&M University, as well as residents of the surrounding areas, as each one of the species collected has the potential to cause human harm. Perhaps the most noteworthy specimen collected with respect to its disease-vectoring capabilities was *Anopheles quadrimaculatus*. This species can be found all through the eastern and southeastern United States (Figure 5).

Fig. 5. Distribution of *Anopheles quadrimaculatus* throughout the U.S.

As was previously stated, A. quadrimaculatus is historically the most important vector of malaria in the United States. Malaria can present itself in both a complicated and uncomplicated form. Those who contract the the complicated form of the disease may suffer organ failure, seizures, coma, anemia, hypotension, respiratory distress, kidney failure, and even death. In an effort to protect Americans, malaria was eradicated from the United States in the 1950's and most cases since that time have been quickly reported to the CDC, and the infected individuals have been promptly quartantined (Benedict,

Levine, and Peterson 2004). Although malria is no longer endemic to the United States, the presence of A. quadrimaculatus is still a matter of great importance. It means that if malaria were ever to make its way back to the U.S., there is a competent vector to transmit it. This is something essential to know before hand, given the issue ever arises.

Along with the possible threat seen from the presence of A. quadrimaculatus, there is also the threat of disease from Aedes triseriatus. This particular species, commonly known as the Eastern treehole mosquito, is a known vector of La Crosse Encephalitis. Although many people who are infected with this disease are asymptomatic, some individuals contract the more severe form, which presents itself with fever, nausea, vomiting, and fatigue. Subsequently, the disease can affect the nervous system, and may cause swelling of the brain, seizures, coma, and paralysis. The severe form of La Crosse Encephalitis is thought to be more common in younger people (McJunkin, los Reyes, et. al. 2001). In contrast to the presence of malaria, the presence of La Crosse Encephailits by A. triseriatus is a much more viable threat to those in the College Station community, since it is known to be currently endemic to the United States.

The final collected species to be discussed, Culex salinarius, is thought to be a possible vector for St. Louis Encephalitis, although the matter continues to be debated. This disease presents itself in a way similar to La Crosse Encephalitis, with the only difference being that a long term infection has been known to result in serious physical or behavioral disability, or even death.

The knowledge of the various mosquito species found in the College Station area, along with the possible diseases they may vector, is soley for informative purposes. It is important to understand that the information obtained during the course of this study does not guarantee that the diseases mentioned are currently present, or will be present in the area described at any given time.

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