Identification and Analysis of Potential Vectorial Capacity in Post-hurricane Mosquitoes (Diptera: Culicidae) Obtained in Brazos County, Texas

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Abstract: In late August, Hurricane Harvey devastated Harris County and surrounding areas, leaving behind pools of stagnant water and creating the perfect conditions for mosquitoes to thrive. Flood-borne mosquitoes, such as those belonging to the genus *Aedes*, are commonly found in the Southern Texas region and are known to vector harmful diseases such as Zika. Therefore, concerns of tropical disease outbreaks in affected areas were a topic of discussion among invested individuals. The conditions of the mosquito population in Brazos County, located within 100 miles of Harris County, were explored in this study to determine the extent of the impact Hurricane Harvey had on the area. Due to the frequent rainfall and minor flooding Brazos County experienced during the hurricane, an increase in flood-borne mosquitoes was expected. Mosquito larvae were collected within a month after Hurricane Harvey from four different locations in the Brazos County area. Within these four locations, four different species were identified: *Aedes vexans, Culex quinquefasciatus, Psorophora columbiae, and Culex coronator*. *Aedes vexans, Culex quinquefasciatus,* and *Psorophora columbiae* are all commonly found in Texas. However, *Culex coronator* is not native to the Southern Texas region. When present, *C. coronator* and *C. quinquefasciatus* are known to vector West Nile virus and St. Louis encephalitis in Texas. *A. vexans,* a flood-borne mosquito species, is known to be a potential vector of Zika virus. Additionally, *P. columbiae* is a primary vector of encephalitis.

Key words: *Culex quinquefasciatus, Aedes vexans, Culex coronator,* vector-borne, flood-borne

Storms that introduce major rainfall to an area are known to produce substantial increases in the mosquito populations of that region due to increased available standing water (Watson 2007). The growing populations can be divided into two categories: the nuisance species present immediately following rainfall, and the major disease vector species that breed two weeks to two months after rainfall (Johnsen 2016). Mosquito samples from Brazos County, specifically College Station, Texas and Texas A&M University, were collected and identified in order to determine which species were present one to two months following rainfall from Hurricane Harvey. Species were identified to determine if these specimen held the potential to vector diseases known to be transmitted in southeast Texas. Vector species potentially residing in the area are known be capable of transmitting diseases such as Zika Virus, Malaria, West Nile Virus, and Dengue Fever (Johnsen 2016). Such information is necessary to keep the public informed about a potential increase in personal health risk and to properly focus control efforts of the local agencies.

Materials and Methods

Brazos County Texas was surveyed for potential mosquito breeding locations following substantial rain from Hurricane Harvey (25 August 2017). Areas with standing water, little to no fish inhabitation, and proximity to human populations were noted and selected for collection.

Collection:

A small, dirty water pond near the National Center for Therapeutics Manufacturing Building at Texas A&M University (College Station, TX - 30.609075, -96.360066), a small stream in the Pebble Creek Residential Area (College Station, TX - 30.561403, -96.229661), dirty puddles near The Satellite Utility Plant at Texas A&M University (College Station, TX - 30.608307, -96.346445), and dirty puddles near Southern Oaks Park (College Station, TX - 30.561669, -96.274967) were determined to potentially harbor mosquito larvae and therefore selected as sampling locations. Samples were collected on 15 September 2017, 30 September 2017, 15 September 2017, and 1 October 2017 respectively. Larval dippers were constructed from measuring cups attached to rods. They were then dipped into selected bodies of water in the areas identified. Larval hatchers (BioQuip Products Inc., Rancho Dominguez, California) were used to obtain samples in addition to the makeshift dippers. Samples were transferred from the dippers into hatchers, if they were not already in them.

Preservation:

Both larval and adult samples were used in identification and classification of specimen. Consequently, 2-3 larvae from each dip were removed from the larval hatchers prior to incubation. Specimen were first fixed in very hot water and then placed into 70% EtOH (ethanol) to preserve the samples for future identification. The remaining samples were then placed into 27℃ incubators with cotton balls saturated in 10% $C_{12}H_{22}O_{11}$ (sucrose) solution to provide nutrients to developing adults. Full grown adult samples were euthanized by freezing (Turell 2000) and stored in petri dishes for later identification.

Identification:

Following the preservation and storage of both larval and adult specimens, each was identified, sexed, and classified to species level by using microscopes and mosquito identification keys. The species obtained were then analyzed based on their ability to cause human diseases and the potential effects were noted.

Results:

Mosquito **larvae** and adults were identified using standard identification keys. From the four locations where mosquito larvae were collected, four unique species were identified (see Table 1 below). *Aedes vexans* (Figure 1) mosquitoes were identified at The Satellite Utility Plant and Southern Oaks Park. *Culex quinquefasciatus* (Figure 2) was found at The Satellite Utility Plant and Pebble Creek Residential Area. Additionally, *Culex coronator* and *Psorophora columbiae* (Figure 3) were also identified. Although found in some parts of Texas, *Culex coronator* is not commonly found in Brazos County (https://agrilife.org/aes/mosquitoes-of-texas/). The four larvae from Southern

Oaks Park all emerged into adults before a larval sample could be preserved.

Location	**Date Collected**	**Species Collected (Adults and larvae)**
The Satellite Utility Plant at Texas A&M University (College Station, TX - 30.608307, -96.346445)	September 15, 2017	*Aedes vexans* (5 adults), *Culex quinquefasciatus* (1 adult, 2 larvae)
The National Center for Therapeutics Manufacturing Building at Texas A&M University (College Station, TX - 30.609075, -96.360066)	September 15, 2017	*Culex coronator* (6 adults; 15 larvae)
Pebble Creek Residential Area (College Station, TX - 30.561403, -96.229661)	September 30, 2017	*Psorophora columbiae* (2 larvae) *Culex quinquefasciatus* (4 female, 2 male adults)
Southern Oaks Park (College Station, TX - 30.561669, -96.274967)	October 1, 2017	*Aedes vexans* (3 male, 1 female adults, 0 **larvae**)

Table 1 Collection Results

Figure 1 Culex quinquefasciatus, a female specimen collected from South Oaks Park in College Station, TX.

Figure 2 Aedes vexans, a female specimen was collected from Satellitw Utility Plant at Texas A&M University, College Station, TX.

Figure 3 Psorophora columbiae, a larval specimen collected from the Pebble Creek residential area in College Station, TX.

Discussion

The goal of this survey was to collect mosquitoes around the Bryan/College Station area **[deleted text] following** Hurricane Harvey in order to determine which species were the most prevalent and what diseases they could potentially vector. Four different species of mosquito, *Aedes vexans, Culex quinquefasciatus, Culex coronator* and *Psorophora columbiae*, were collected from the previously designated locations. *C. coronator* is not typically found in Texas, and is therefore unusual when compared to its counterparts. *C. coronator* has been confirmed to vector West Nile virus in Texas and to vector St. Louis encephalitis, Venezuelan encephalitis and Ilheus virus in South American countries (Harrison, 2010). *C. quinquefasciatus* is notably dangerous to humans as it is the primary vector of West Nile virus and St. Louis encephalitis in Texas (Johnsen, 2016). West Nile virus is commonly found in the southern United States and specifically Texas (Morin, 2013). The discovery of *C. quinquefasciatus* demonstrates that there is a likelihood that the disease is vectored in the area, putting the population at risk. *Ae. vexans* has been shown to be a potential vector of the Zika virus, demonstrated in one study where 34% were able to transmit the virus (O'Donnell, 2017). Additionally, *Ae. vexans* is also known to vector Eastern Equine Encephalitis Virus (EEEV) (Molaei, 2015). Found in the north eastern areas of the United States, EEEV is known to infect both humans and livestock (horses, birds, donkeys). This could potentially both cause economic issues, as well as endanger those living in the area, if the virus were to be introduced there. *P. columbiae* has been shown to transmit some forms of encephalitis, but is uncommon (Merchant, 2016). The findings of this survey demonstrate that the rain following Hurricane Harvey, as well as the geographical location of Bryan/ College Station, makes the region prime for vector borne diseases. Diseases such as West Nile Virus and other encephalitic viruses are likely to be prevalent in the area based on the vectors found and diseases previously established. While each specimen was not tested for these potential diseases, based on the species of the specimen and the known diseases in the region, **the diseases that are most likely to be present can be determined [deleted text].** These diseases **may** have a profound effect on the population in the area if they are in fact present. Moving forward with the information obtained from this study, it is crucial that appropriate measures be taken to reduce mosquito populations in the Bryan/College Station area. If mosquito populations, such as *C. quinquefasciatus*, are allowed to increase in number, it is likely that the infection rates of vector-borne diseases will also increase. Finally, in the future, more mosquito collections should be performed on a broader scope to ensure collection of all prevalent species in the Bryan/College Station **area**. Additionally, if the appropriate equipment is available, each species collected should be screened for various vector-borne diseases common in Texas. As an extra measure of vector-borne disease in the area, **[deleted text]** hospitals, clinics, and doctor's offices should be accounted for in determining the pathogens present in the area at the time of the collection. These final provisions would enhance the results of this survey, and increase the knowledge surrounding this topic of vector borne diseases.

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