

Relationship between Mosquito Species Distribution and Human Population Density

Emily Barnett, Josh Hughes and Drake Duncan
Texas A&M University - College Station

Edited by Franchesca Rodriguez

Abstract: Mosquitoes are known to exhibit different feeding behaviors, with some differences between mammalian or avian hosts. Many of them vector life-threatening diseases and pose a threat to public health and safety. When coupled together, mosquitoes that prefer to be around people could be more likely to transmit disease to those individuals. If it is possible to predict and map the potential mosquito species and vectors that are most closely associated with people, it would serve as an invaluable tool in combating disease. In an effort to see if this was possible, an experiment was done by surveying the mosquito larvae around College Station, TX in areas with varying population densities. The mosquitoes were identified down to the species taxonomic level and plotted against the population map of Brazos County. Mosquito species varied widely by location, with different feeding preferences per each area surveyed. When results were evaluated for any possible trends, it was found that areas with high populations did not show a preference for any one species or genus and did not yield species that preferred to feed on people.

Key Words: relationship, mosquito, distribution, population

Global public health is a growing concern worldwide and mosquitoes are an extremely competent vector near the forefront spreading disease. In 2014 there were 379 reported West Nile virus cases (6 deaths), 114 chikungunya cases, 34 dengue virus cases, and 4 Saint Louis encephalitis virus cases, totaling to 531 human illnesses in Texas attributed to arboviruses transmitted by mosquitoes (Texas DSHS 2015). Many of these diseases have dire effects on the host and may even result in death. Mosquito vectors such as *Aedes aegypti*, *Aedes albopictus*, *Psorophora confinnis*, *Anopheles sp.*, *Culex pipiens*, and other *Culex sp.* are responsible for the spread of debilitating mosquito-borne diseases (Mullen and Durden 2009). In addition to the existence of these vectors in the state of Texas, both urban

and rural areas provide hosts and suitable habitation.

Adult male mosquitoes do not blood-feed and as a result do not play a direct role in the transmission of diseases to vertebrate hosts. Adult females serve as the core of concern because they are hematophagous and feed on a wide range of hosts depending on the species. Factors such as olfactory cues, habitation availability, host availability and feeding behavior play a role in host preferences (Takken and Verhulst 2013). As a result, humans and other mammals are vulnerable to mosquito-borne diseases.

Different geographic locations provide various resources necessary for the growth, development and reproduction of mosquitoes. We expect that there will be a marked difference in mosquito species

distribution in relation to human population density based on their blood feeding preferences. This will allow us to observe which mosquito species are more commonly associated with humans, and thus more likely to vector disease to those individuals.

Materials & Methods

For this research study, we collected and identified mosquito larvae for analysis. Mosquito larvae were collected using a milk carton, with the tip cut off, in four different geographic locations. The geographic locations were chosen based off varying levels of human population density and availability of larval habitation. The four geographic locations include: Research Park, Stevenson Companion-Animal Life Center, Best Little Horse House in Texas, and near the Heep Center at Texas A&M University (more details on these locations are listed below in the results section). After the larvae were collected, the water was filtered out using a small fish net. The specimens were

initially stored in plastic Crystal Light containers using Klean Strip Green Denatured Alcohol (contains ethanol and methanol) in order to preserve them. They were identified first to genus using a dissecting microscope and then identified to species using a compound light microscope. The CDC pictorial key of arthropods and Photographic Guide to Common Mosquitoes of Florida was used to identify the specimens. The specimens were transferred to small glass vials with a plastic cap and stored in 80% ethanol. The sample sizes were quite large and only a portion of the total sample size was identified from each site using random sampling.

A 2000 Census map of Brazos County was used to observe the relative distribution of human population. Mosquito species distribution relative to human population density was used to determine which species are closely associated with humans and other vertebrate hosts.

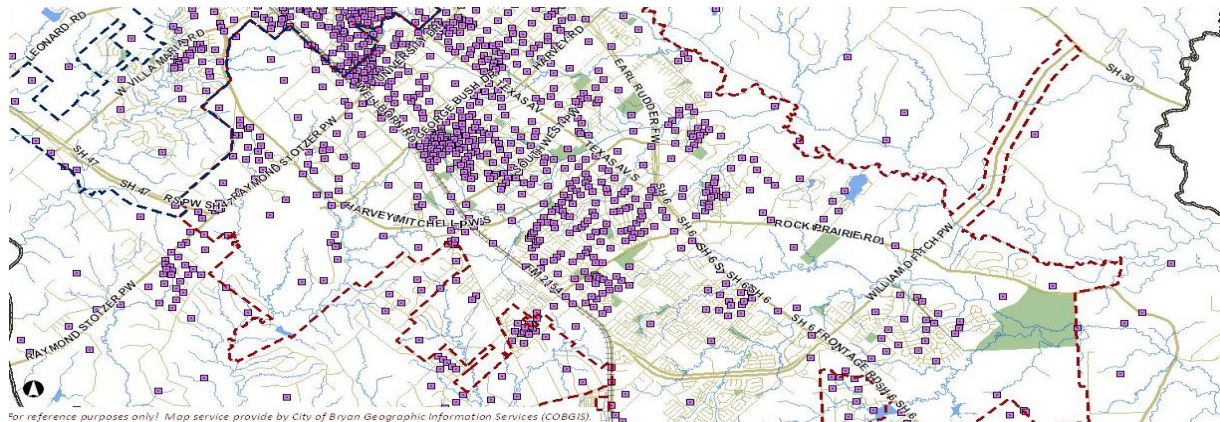
Results

Mosquito Larvae Collections

1. Location: Research Park (30° 36' 12.056" N , 96° 21' 37.943" W)
 - a. Collection date: 9-X-2015
 - b. Habitat: Standing water
 - c. Total mosquitoes identified: 95
 - i. *Aedes vexans* total collected: 74
 - ii. *Coquillettidia* sp. total collected: 20
 - iii. *Psorophora confinnis* total collected: 1
- b) Location: Stevenson Companion-Animal Life Center (30° 36' 31.691" N , 96° 21' 22.991" W)
 - a. Collection date: 29-X-2015
 - b. Habitat: Flood water
 - c. Total mosquitoes identified: 24
 - i. *Aedes vexans* total collected: 19
 - ii. *Aedes dorsalis* total collected: 2

- iii. *Aedes aegypti* total collected: 1
 - iv. *Psorophora confinnis* total collected: 1
 - v. *Culex* sp. total collected: 1
3. Location: Best Little Horse House in Texas (30° 33' 58.688"N , 96° 12' 16.981" W)
 - a. Collection date: 15-XI-2015
 - b. Habitat: Standing water
 - c. Total mosquitoes identified: 50
 - i. *Culex* sp. total collected: 49
 - ii. *Culex restuans* total collected: 1
 4. Location: TAMU Campus near Heep Center (30° 36' 38.813" N , 96° 20' 53.625" W)
 - a. Collection date: 6-XI-2015
 - b. Habitat: Standing water
 - c. Total mosquitoes identified: 24
 - i. *Culex pipiens* total collected: 15
 - ii. *Culex tarsalis* total collected: 4
 - iii. *Culex restuans* total collected: 2
 - iv. *Culex nigripalpus* total collected: 3

Discussion



Using data from the 2000 census, Brazos County has a population density map that can be used to make approximations of general distribution trends. In this map legend, each dot represents a population of one-hundred.

The 2000 Census map of Brazos County showed from most densely populated to less densely populated: Near the Heep Center at Texas A&M University-College Station, Stevenson Companion-Animal Life Center, Research Park, and lastly Best Little Horse House in Texas. Using the collection data and

geographic coordinates, we tried to determine a correlation between the mosquito species relative to human population density. However, the data we obtained did not show a strong correlation.

In the most densely human populated area, a hole filled with standing water near the Heep Center at Texas A&M University-College Station contained: 15 *C. pipiens*, 4 *C. tarsalis*, 2 *C. restuans*, and 3 *C. nigripalpus*. The next most densely human populated area, flood water in a ditch near Stevenson Companion-Animal Life Center contained: 19 *A. vexans*, 2 *A. dorsalis*, 1 *A. aegypti*, 1 *P. confinnis*, and 1 *Culex* sp.. The third most densely human populated area, standing water near Research Park, contained: 74 *A. vexans*, 20 *Coquillettidia* sp., and 1 *P. confinnis*. The least densely human populated area, standing water in a horse water trough at Best Little Horse House in Texas, contained: 49 *Culex* sp. and 1 *C. restuans*.

The results took us by surprise. What we expected to find was for there to be a clear correlation between the population density and the preferred host of a mosquito. We expected areas that had a high population density like at the Heep Center to have an abundance of mosquitoes that preferred mammals and humans as their host, such as the members of the *Aedes* genus. Instead, what we found was that all of the species belonged to the genus *Culex*, which prefers primarily birds. *Culex* species were found everywhere except Research Park, which is strange considering *Culex* has a preference for birds (Apperson et al. 2002, Day 1997, Pahk 2003).

The only location where the species of mosquitoes seems to fit with the population density is at the Stevenson Companion-Animal Life Center, which is near the Texas A&M Large Animal Hospital that has a constant influx of cows, horses, and people that would sate the appetite of *Aedes* and *Psorophora* species; which were found at this location (Apperson et al. 2002, Robineau-Desvoidy 1827, Meigen).

Since there was no clear correlation between the population density and the species of mosquitoes that were identified, especially taking into account the feeding preferences of the mosquitoes, we concluded that human population density has little effect on the mosquitoes species compared to other possible contributing factors. Influences that likely had a higher impact than population density on mosquito species distribution could include the habitat where the mosquito larvae were found - such as long-standing water or flood water - or the level of development and infrastructure of an area sampled, which could limit the availability of habitation. Further testing would need to be done to conclude whether or not the distribution of mosquito larvae is affected by population density or just the result of habitat limitations in the area.

There were a concerning number of obstacles that limited the feasibility of conclusions derived from our study. Small sample sizes and the restriction to only four geographic locations at singular instances limited the ability to determine a distinct correlation and corresponding causality. Even among the samples that were collected, the materials of species determination available, i.e. the class lab manual, did not possess the capacity to identify a significant portion of the larvae collected. Some of the mosquito specimens desiccated from a few preservation errors and could not be identified. The census map used to determine the population density of the four geographic regions is from the year, 2000, providing outdated information. The census map also is decidedly imprecise in the way it represents population and population distribution. It utilizes dots that represent a fixed value of population but does not overlap the dots, giving population counts at places in College Station where people do not live.

Future studies could use larger sample sizes and collect specimens from more locations representing a more or less populated area. Larvae could also potentially be reared for easier adult identification. It would also be beneficial to use a more current census map of Brazos County to more accurately represent human population distribution. A population heat map would be the easiest way to analyze the distribution. GIS map resources can be of great potential use in many scientific facets. FEMA flood plain topographic maps can be used for

epidemiological and natural disaster plan development. A great deal of information can likewise be obtained concerning relationships with humans when population data is up-to-date and well presented. GIS maps can also indicate the geographic location of particular group entities such as school districts and neighborhood associations that could be of importance when discerning social and organizational groups to address when there are concerns of outbreak or incident.

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