Diurnal Activity of Gravid *Aedes aegypti* (Linnaeus) (Diptera: Culicidae) in Toco, Trinidad

Patryk Tomaszkiewicz and Dr. Adrienne Brundage

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Abstract: Mosquitoes pose a threat to human health due to a variety of arboviral diseases that they are able to transmit. Many of these diseases are vectored by *Aedes aegypti* and most are prevalent in many parts of South America and The Caribbean. Gravidity, diurnal activity, and the reproductive capabilities of *Aedes aegypti* are important to research because future generations of mosquitoes can be studied or eliminated in hopes of reducing future outbreaks of disease. New findings would help researchers obtain new ways of preventing future cases of disease, and would reduce the impact that this health-endangering mosquito has on local communities. A survey of the Jammev Beach Resort in Toco, Trinidad was conducted to determine what time of day had the highest concentration of gravid *Aedes aegypti*. In order to catch the mosquitoes, diaphoretic clothing was left in an open area. This clothing was used to lure the mosquitoes to the preselected location and sticky cards were used to efficiently catch the mosquitoes. This sweat-baiting method could be replicated and applied to future research in order to test its full potential. Results showed that gravid *Aedes aegypti* were found in higher concentrations at dawn and at high noon. It was also concluded that both gravidity and mosquito presence decreased as the day progressed. Lengthier studies with more effective trapping methods should be conducted during the wet season to fully understand the activity and reproductive capabilities of *Aedes aegypti*.

Keywords: Arbovirus, sweat-bait, vector, mosquito, health

Aedes aegypti (Linnaeus) is abundant in tropical climates and prefers to be around human hosts, often using areas of human activity to obtain a blood meal and then reproduce. *Aedes aegypti* lays its eggs in standing water, preferring items such as used tires, buckets, flower pots, or puddles as ideal locations. These eggs are laid in clutches, and give rise to hundreds of new mosquitoes capable of vectoring disease (Christophers 1960). Information regarding the reproduction and behavior *Aedes aegypti* is crucial for controlling the spread of many arboviral diseases (Beaty 1996). Mosquito reproduction and behavior is an important topic to understand because new information can help researchers construct effective measures to decrease gravidity in female mosquitoes. Information on the behavior of *Aedes aegypti*, such as diurnal activity, will provide basic information on the daily activity of this mosquito. Information on the reproduction, ecology, and behavior of *Aedes aegypti* is needed to predict where arboviruses transmitted by this mosquito will most likely occur. Pinpointing the time period that has the highest amounts of this mosquito can lead to efforts being made to diminish *Aedes aegypti* during this time. This will also reduce the amount of people bitten by this mosquito and will reduce arboviral transmission. A survey of gravid *Aedes aegypti* was conducted in a preselected location at the Jammev Beach Resort in Toco, Trinidad (10.826429, -60.932714). To capture gravid *Aedes aegypti*, sweat-baiting was used to lure the mosquitoes to a preselected site. This consisted of laying out diaphoretic articles of clothing and then using sticky pads to capture mosquitoes aggregating near the clothing. This method was used because pilot studies showed

that the Bioagents™ GAT trap was ineffective in catching gravid *Aedes aegypti*. The information obtained could be shared with local governments and used to create future prevention programs for many arboviruses transmitted by *Aedes aegypti*.

The goal of this study is to identify what time of day has the highest density of gravid *Aedes aegypti* in Toco, Trinidad. The data obtained as a result of this study could also be used to help diminish current and future populations of *Aedes aegypti*.

Materials and Methods: A sweat-baiting technique was used to catch the mosquitoes and consisted of laying out diaphoretic articles of clothing in an open area and then waiting for the mosquitoes to present themselves (Fig. 1). The mosquitoes were caught by moving and rustling through the diaphoretic clothing and using Bioagents™ GAT sticky cards to adhere the mosquitoes as they escaped from the clothing.

Mosquitoes were collected and counted three times a day at dawn, noon, and dusk. This gave an approximation for the time of day the gravid *Aedes aegypti* were most abundant. After collection, all the mosquitoes were identified (Darsie & Ward) but only individuals of *Aedes aegypti* were separated according to their sex. Gravidity was measured by dissecting the females and identifying whether they had a presence or absence of eggs. If the females contained any eggs at all, then they were considered to be gravid. Dissections were conducted under a dissecting microscope and a pair of handling forceps were used to open the mosquito abdomen. Tallies were done to keep an accurate record of the total amount of mosquitoes caught, the number of each species, the number of *Aedes aegypti*, the number of male and female *Aedes aegypti*, as well as the number of gravid *Aedes aegypti*.

Figure 1: Two pictures showing position and use of sweat-bait traps. Diaphoretic articles of clothing were hung over a chair and left to sit. Observations and collections were done in 30 minute intervals around the trap's location.

Results: A total of 131 mosquitoes were caught by implementing the sweat-baiting method, and 67 of these mosquitoes were *Aedes aegypti* (Fig. 2). Other mosquitoes caught included: *Aedes vexans* (Meigen) (four individuals, *Anopheles pseudopunctipennis* (Theobald) (one

individual), *Psorophora columbiae* (Dyar & Knab) (five individuals), *Culiseta impatiens* (Walker) (two individuals), *Anopheles quadrimaculatus* (Say) (six individuals), and *Psorophora spp.* (one individual) that could not be identified down to species. (Fig. 3.)

Figure 2: Female Aedes aegypti. Jammev Beach Resort, Toco, Trinidad. May 2018.

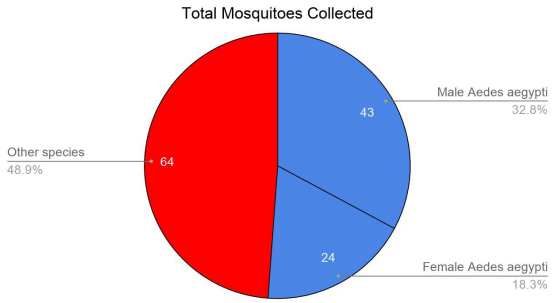

Figure 3: Summary of all mosquitoes collected. Amounts and percentages shown. Aedes aegypti split by sex.

Of all the *Aedes aegypti*, 43 were male and 24 were female. According to the time of day that the *Aedes aegypti* were caught, 34 were caught at dawn, 21 were caught at noon, and 12 were caught at dusk. 13 females were gravid, but 11 of which were not implying that they had already laid their eggs or have not become gravid yet. Seven gravid females were collected at dawn, five gravid females were collected at noon, and one was collected at dusk. Whereas for the female *Aedes aegypti* that were not gravid, two were collected at dawn, two were collected at noon, and seven were collected at dusk (Fig. 4). Of the 34 *Aedes aegypti* that were caught at dawn, 25 were males and nine were female. From the 21 *Aedes aegypti* caught at noon, 13 were male and eight were female. And of the 12 that were caught at dusk, six were male and six were female (Fig. 5).

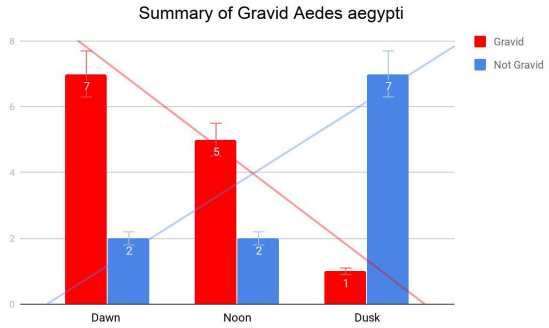

Figure 4: Summary of gravid Aedes aegypti collected throughout the daytime. Amounts of gravid and non-gravid Aedes aegypti shown with 10% error accounted for. Trendlines show decreasing gravidity but increasing amount of non-gravid Aedes aegypti.

Percentage-wise, 51.1% of all mosquitoes collected were *Aedes aegypti* and of the *Aedes aegypti*, 35.8% were female (Fig. 3). 54.2% of the females were gravid (Fig. 4). Comparing the time of day that the *Aedes aegypti* were caught, 50.7% were caught at dawn, 31.3% were caught at noon, and only 17.9% were caught at dusk From the *Aedes aegypti* that were caught at dawn, 73.5% were male and 26.5% were female. The *Aedes aegypti* caught at noon were 61.9% male and 38.1% female. Lastly, the *Aedes aegypti* that were caught at dusk were 50% male and 50% female (Fig. 5).

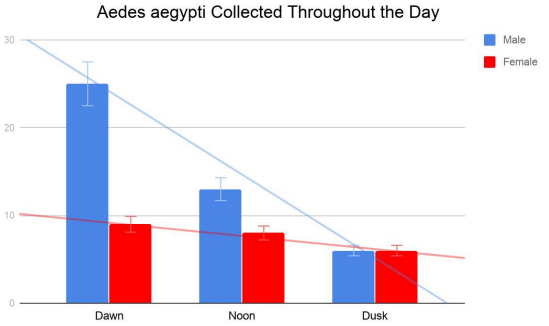

Figure 5: Summary of Aedes aegypti collected throughout the daytime. Amounts of Aedes aegypti shown with 10% error bars accounted for. Trendlines present displaying decreasing amounts of male and female Aedes aegypti.

Discussion: Very close to half of the mosquitoes collected were *Aedes aegypti* with a very large number of other *Aedes* species as well (Fig. 1). *Aedes* species are numerous in tropical habitats, particularly ones that breed in standing water, such as *Aedes aegypti* (Mullen 2009). Because of these conditions, there is no surprise that there are so many *Aedes aegypti* present in Toco, Trinidad. This is an important observation to state because *Aedes aegypti* dwells in habitats in or around human homes and often lays its eggs in human made articles such as buckets or tires (Harbach & Knight 1980, 1981). A large number of mosquitoes, especially of the genus *Aedes*, also form mating flight swarms shortly after eclosing where the males cluster together and follow looping paths in order to attract females. These mating swarms often times include several different species of mosquitoes as well as a few mosquitoes of a different genus. Female *Aedes aegypti* are attracted to these swarms and fly inside, where they are detected by their differing wingbeat frequency and met by their male counterpart (Hartberg 1971). These mating swarms were observed many times during collection with most of the mosquitoes being males, with a few females. These females become gravid shortly after copulation and are anautogenous, requiring a blood-meal before laying their eggs (Clements 1963). It is known that males develop faster and pupate earlier than females, posing a reason as to why so many males were collected in contrast to the number of females (Mullen 2009) (Fig. 5).

It was hypothesized that the gravid *Aedes aegypti* would be most prevalent during the dusk hours of the day. This was inferred because it is common that people obtain mosquito bites in the late afternoon when the sun is setting. It was also hypothesized that due to the heat and humidity, *Aedes aegypti* would prefer to stay indoors or stay dormant until after the sun would set and when the temperatures would decrease (Beaty 1996). However, this hypothesis was disproved because it was observed that as the day went on, fewer *Aedes aegypti* were caught and gravidity decreased in the females that were caught. This shows that *Aedes aegypti* are most abundant and highly active in the morning to high noon, but mostly dormant at dusk. Opposed to the idea that *Aedes aegypti* are night feeders, it is apparent that this species thrives in the middle of the day when it is the hottest and most humid (Christophers 1960). During this time of day, it was very common to see mating swarms of mosquitoes and the abundance of them was much higher than at dusk. From the data, it can also be concluded that female *Aedes aegypti* lay their eggs in the period between dawn and high noon but rarely at dusk, supported by the decreasing trend in the number of gravid females obtained. Instead of laying her eggs in the evening, female *Aedes aegypti* most likely lays their eggs in the morning or at high noon and then spend the rest of the day blood feeding or resting (Hartberg 1971).

Due to the fact that *Aedes aegypti* is a daytime feeder, it would be optimal for the female to lay her eggs as soon as possible and then spend the remainder of the day consuming blood meals and resting in order to propagate more eggs. These decreasing amounts of concentration and gravidity indicate that they are directly proportional and are related to one another. Hence, it can be expected that earlier in the day between

dawn and high noon, there will be a higher concentration of gravid *Aedes aegypti*. Contrastingly around dusk, there will be a lower concentration of gravid *Aedes aegypti* (Mullen 2009).

Future research should focus on the sweat-baiting method to test its full potential and to determine its effectiveness in catching *Aedes aegypti* or other species of mosquitoes that are dangerous to human health. Efforts should also be made to elongate this study so that it lasts a long enough time to encompass the dry and wet seasons, and to contrast the diurnal activity of *Aedes aegypti* during those times. Gravid *Aedes aegypti* could also be collected and used over this longer period of time to determine which season produces more mosquitoes, or to determine when they are most active. Other mosquitoes could be studied or other variables such as a contrast between an urban or rural environment could be tested to determine whether *Aedes aegypti* prefers an urban or rural environment. Future research on these topics is important to fully understand the behavior and reproductive capabilities of *Aedes aegypti*. Information on these topics will help future researchers and government officials make accurate and beneficial decisions that will diminish populations of *Aedes aegypti* and will ensure a safer community with fewer outbreaks of disease.

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