Dehydration alters mosquito reproduction and blood feeding propensity to shift vectorial capacity

Dhriti Sharma, Christopher J. Holmes, Elliott Brown, Blaine Payton, and Joshua B. Benoit

Department of Biological Sciences, McMicken College of Arts and Sciences, University of Cincinnati

ABSTRACT

Mosquitoes are vectors of malaria, filarial nematodes and many viruses which makes them one of the deadliest animals in the world. However, research has been inadequate on how dry environments influence aspects of mosquito biology that range from survival to disease transmission. The goal of this study was to determine the impact of dehydrating conditions on mosquito blood feeding and reproduction, specifically in species *Culex pipiens* a vector of West Nile virus, and *Aedes aegypti*, a vector of yellow fever, dengue, and Zika viruses. Mosquitoes that were blood fed before dehydration increased survival time when compared to non-blood fed mosquitoes. Dehydrated mosquitoes showed a greater blood feeding propensity when compared to fully hydrated individual, suggesting the utilization of a bloodmeal for rehydration. Dehydrated mosquitoes are likely using blood meals for survival, water content regulation, and repairing dehydration-induced stress damage rather than reproductive investment. This shifted investment results in dehydrated mosquitoes laying fewer eggs than their hydrated counterparts, even though the bloodmeal is slightly larger. Our results indicate that dehydration will alter blood feeding propensity and reproductive output, which will shift mosquito vectorial capacity under dry conditions. These results are critical as climate change is expected to increase the duration and severity of drought.

MATERIALS AND METHODS

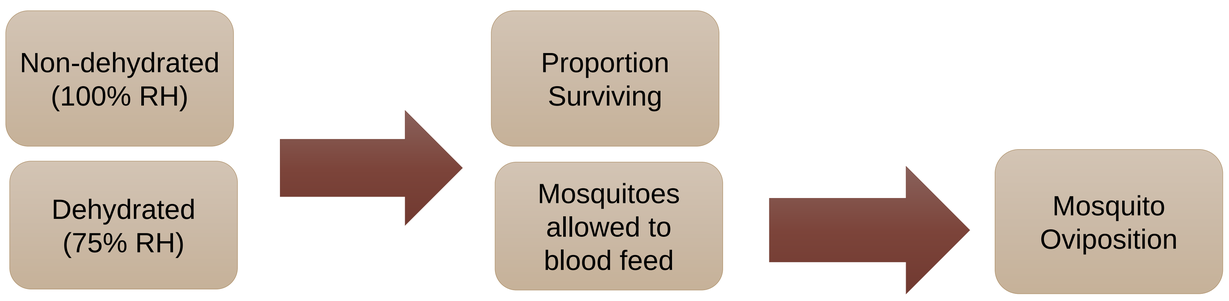


Figure 1: Survivability and Oviposition protocol. *Culex pipiens* and *Aedes aegypti* were exposed to 100% (non-dehydrating) relative humidity or 75% (dehydrating) relative humidity. For the survivability assay, a proportion was taken to determine mosquito survival in both conditions. For the reproductive assay, mosquitoes were allowed to blood feed and then oviposit in normal conditions.

RESULTS

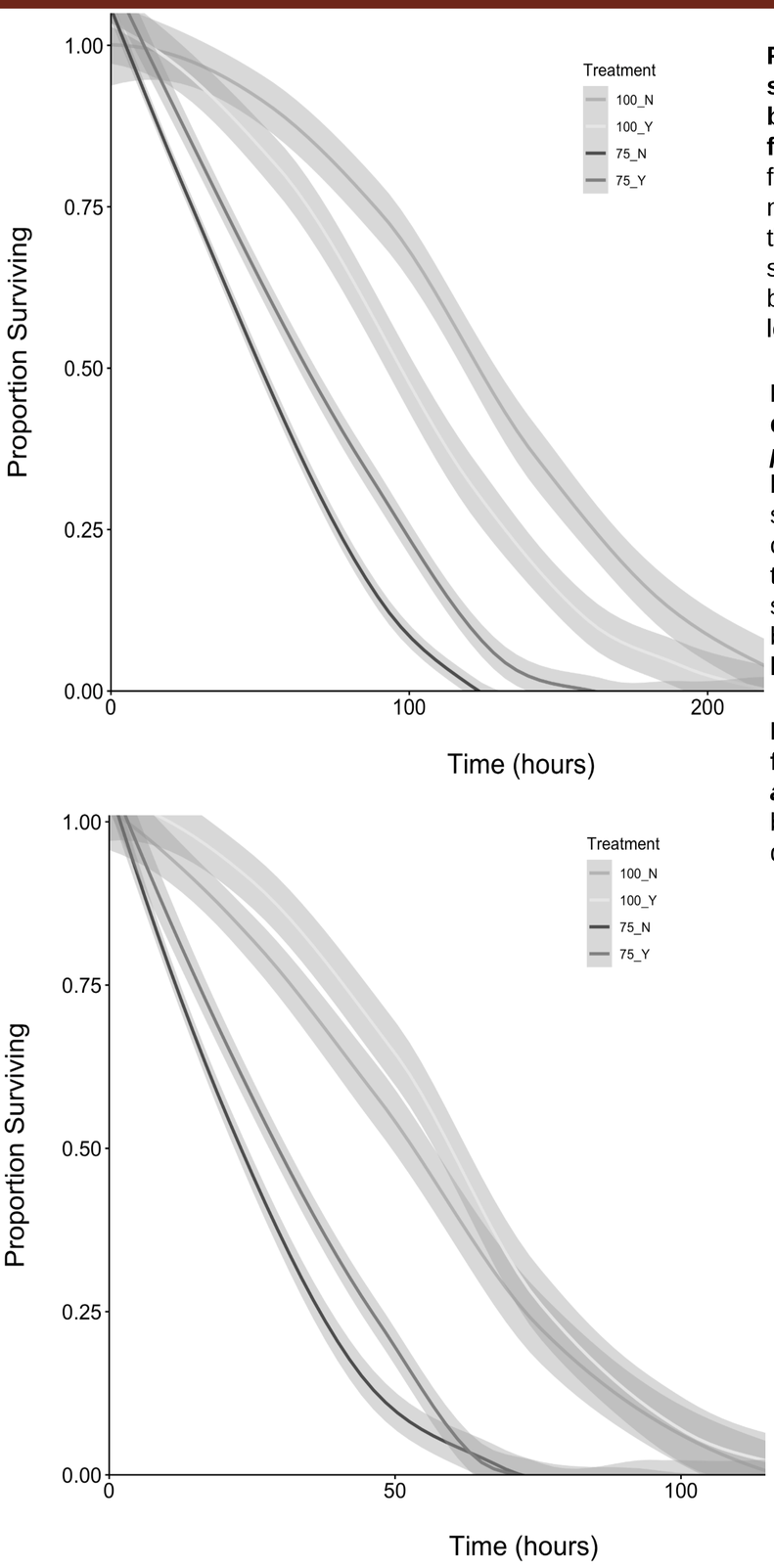
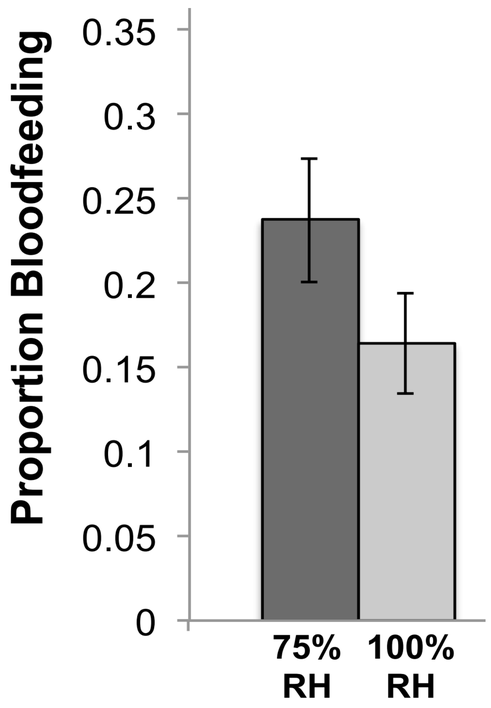


Figure 2 (Top): Dehydration decreases survivability in dehydrated *A. aegypti*, but mortality is delayed by blood feeding. Dehydrated *A. aegypti* survived for a shorter time period when compared to non-dehydrated mosquitoes. Blood fed then dehydrated *A. aegypti* survived for a shorter time period time when compared to blood fed non-dehydrated *A. aegypti* but longer than just dehydrated *A. aegypti.*

Figure 3 (Bottom left): Dehydration decreases survivability in dehydrated *C. pipiens*, but mortality is delayed by blood feeding. Dehydrated *C. pipiens* survived for a shorter time period when compared to non-dehydrated. Blood fed then dehydrated *C. pipiens* survived for a shorter time period time when compared to blood fed non-dehydrated *C. pipiens* but longer than just dehydrated *C. pipiens.*

Figure 4 (Bottom right): Increased blood feeding in dehydrated *C. pipiens* and *A. aegypti*. The dehydrated mosquitoes are blood feeding more than the non-dehydrated mosquitoes.



RESULTS CONTINUED

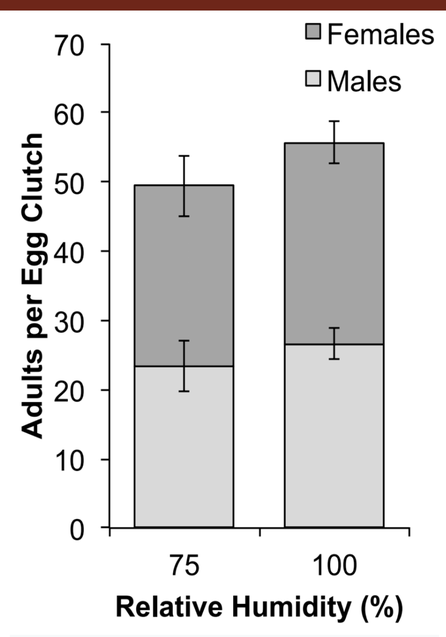
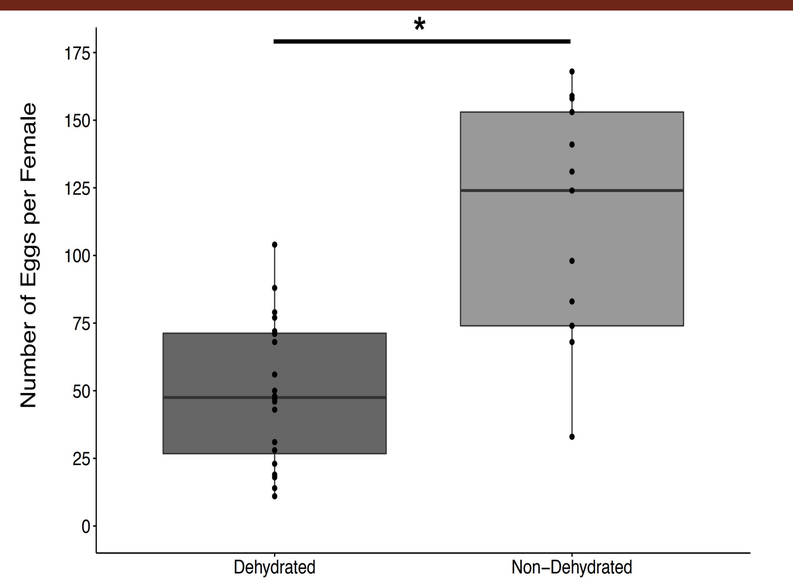
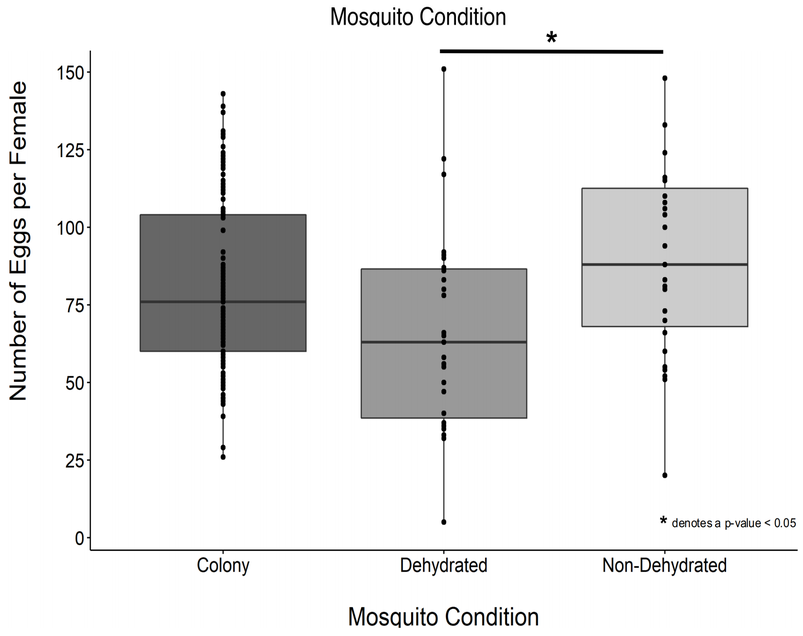


Figure 5 (Top left): No change in sex bias in dehydrated *C. pipiens* and *A. aegypti*. The sex-ratio and hatch rate remained same in *C. pipiens* offspring in both dehydrated and non-dehydrated groups.

Figure 6 (Top right): Lower egg production in dehydrated *A. aegypti* females. *A. aegypti* females laid fewer eggs when they were dehydrated than the females that were non-dehydrated.

Figure 7 (Bottom): Lower egg production in dehydrated *C. pipiens* females. *C. pipiens* females laid fewer eggs when they were dehydrated than the females that were non-dehydrated.





SUMMARY

Mosquitoes are highly susceptible to water loss [1]. Increased water loss will result in lower survivability (Figures 2 and 3). Alternatively, mosquitoes that were blood fed prior to dehydration showed an increased survival time when compared to their non-blood fed counterparts (Figure 2 and 3). Our research has shown that water loss will also induce a greater tendency towards blood feeding in dehydrated mosquitoes than in fully hydrated ones (Figure 4), which may increase viral transmission [2]. These results suggest the utilization of a bloodmeal for rehydration purposes and water content regulation [3]. Despite this, our results have shown that there are no sex biases or hatch rate differences in either the dehydrated or non-dehydrated females' offspring (Figure 5), likely as a result of the nutrients being distributed to each offspring equally by the mother [3]. However, differential use of a bloodmeal for survival purposes negatively influences reproductive output as fewer eggs were laid by dehydrated females when compared to non-dehydrated females (Figures 6 and 7). Dehydration is a critical component in altering vectorial capacity and how it can be calculated. Through our results we can see how dehydration affects on survivability, reproduction and blood feeding propensity can drive vectorial capacity and disease transmission in low-humidity conditions. Future studies will examine how dehydrated mosquitoes are utilizing bloodmeals in various ways and also research the tendency of refeeding in mosquitoes. These results will further solidify our understanding and advance our knowledge on the subject of dehydration in mosquitoes and how it contributes to vectorial capacity and disease transmission dynamics.

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