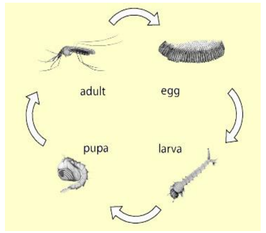
EFFECTS OF POPULATION DENSITY ON THE DEVELOPMENT OF MOSQUITOES

Janel McClain, Technology High School, Rohnert Park, CA.

BACKGROUND

The *Culex pipiens* mosquito, also known as the House Mosquito, is well-known for its habit of breeding around humans in septic systems, sumps, and other containers with high nutrient levels and limited space. *Culex pipiens* has a worldwide distribution and tends to go into people's houses at night to bite, and is a vector of West Nile virus. *Culex pipiens* is the mosquito most likely to transmit West Nile virus to people in Marin and Sonoma Counties. Eight people died from West Nile virus in California in 2011 (1).



The mosquito life cycle, from egg to adult.

An adult *Culex pipiens* mosquito biting a human.

PURPOSE AND HYPOTHESIS

High levels of larval waste have not been shown to impact the development of mosquitoes (2,3). However, toxins produced by bacteria may have negative effects on growth or survival (4). The purpose of this experiment was to determine whether competition for food and breathing space, rather than toxin buildup, negatively affects survival percentage, the mass of the adult mosquitoes, adult wing length, and sex ratio. The hypothesis was that competition among individual mosquito larvae would affect growth and survival. By keeping the living space, water volume and quality, and the amount of food constant while changing only population density, it could be shown that growth and survival percentage of the mosquitoes was dependent on population density.

MATERIALS AND METHODS

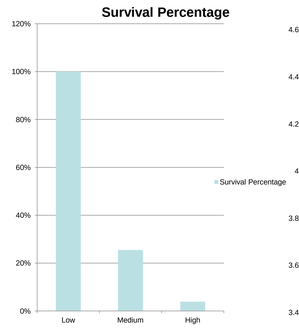
The *Culex pipiens* larvae were obtained from the Marin/Sonoma Mosquito and Vector Control District. The larvae were raised in groups of ten, one hundred, and four hundred per container. The containers used were Mosquito Breeder cages from BioQuip. Equal volumes of distilled water were added to twelve cages and larvae were counted as they were added. The surface area in the Mosquito Breeder is 95 centimeters squared, so cages with ten larvae (low density) had only 0.1 larvae per centimeter squared, or 9.5 centimeters squared per larva. Cages with one hundred larvae (medium density) had 1.0 larva per square centimeter, or 0.95 centimeters squared per larva. Cages with four hundred (high density) had 4.2 larvae per centimeter squared, or 0.24 centimeters squared per larva. The surface area required by *Culex pipiens* larvae is thought to be between 0.9 and 1.8 centimeters squared per larva, or 3 larvae per centimeter squared (5). Larvae were fed every other day with equal amounts of food made from dry cat food, alfalfa pellets, and brewer's yeast finely ground together. Dead larvae were removed and a partial water change was performed twice a week. Pupae were extracted every other day with a screen dipper and transferred to other Mosquito Breeder cages to be allowed to emerge as adults. Adults were starved and dried out in order to be weighed. The adults were weighed with an Acculab precision balance. Wing length was measured with a metric miniscale from BioQuip under a dissecting microscope.

RESULTS

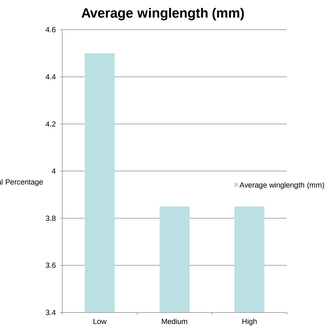
To find the average weight of each group of mosquitoes, the total weight of the surviving adults from each group was found and then divided by the number of survivors. For the groups of ten, the weight averaged out to approximately 0.56 milligrams per adult mosquito. The average weight for the groups of one hundred was just over 0.29 milligrams per mosquito. For the groups of four hundred, the weight per adult mosquito was slightly lower than that of the mosquitoes from the groups of one hundred, averaging to exactly 0.29 milligrams.

To find an average wing length for each group, measurements were taken from six or eight mosquitoes per group, added, and divided by the number of mosquitoes per group. The wing length average for the tens was about 4.5 millimeters. For the groups of one hundred, the average length was 3.85 millimeters. The groups of four hundred averaged exactly the same as the groups of one hundred, at 3.85 millimeters.

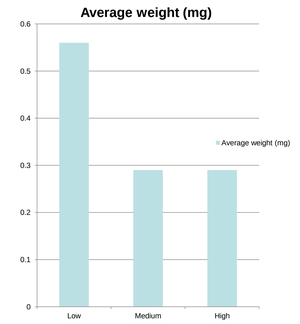
For survival percentage, the total number of adults was found and divided by the number of larvae started with (ten, one hundred, or four hundred). The groups of ten were a complete success, having a survival percentage of 100%. All mosquitoes survived to adulthood. In the one hundreds, an estimated 25.5% of mosquitoes lived to become adults. For the groups of four hundred, a very small 3.9% of mosquitoes made it past the pupal stage.



Survival percentages of mosquitoes at low, medium, and high densities.



Average wing length of mosquitoes at low, medium, and high densities.



Average weight of adult mosquitoes raised at low, medium, and high densities.

CONCLUSIONS

This experiment suggests that population density directly affects development and survival of mosquitoes. In the lowest density group, the average weight and wing length was significantly larger than that of the medium and high density groups. The lowest density group also had the highest survival rate by far, with 100% of adults living at the end. Between the medium and highest densities, there was very little difference between weight and wing length. However, the survival percentages were extremely different, with over 25% of the one hundred group's total survival compared to less than 4% in the four hundred group. Larval density also affected the ratio of females to males in each group. In the tens, there was a sex ratio of 23 females to 8 males, or 2.9 females for every male. For the groups of one hundred, there were 21 females to 37 males, or about .57 females per male. In the groups of four hundred, there were a mere 13 females to 18 males, or .72 females for each male. Because the development time for male mosquitoes is shorter than that of females, it would give them an advantage because they would face less competition for survival needs.

ACKNOWLEDGMENTS

Thanks to the Marin/Sonoma Mosquito and Vector Control District, for providing mosquitoes, cages, measuring devices, and use of the microscope and balance in the laboratory.

REFERENCES

1) Marin/Sonoma Mosquito and Vector Control District website (www.msmosquito.com)
2) Asahina, Syoziro. "Food Material and Feeding Procedures for Mosquito Larvae." Bull. Wld Hlth Org. 1964, 31, 465-466.
3) Roberts, Derek and Michael Kokkinn. "Larval crowding effects on the mosquito *Culex quinquefasciatus*: physical or chemical?" Entomologia Experimentalis et Applicata, 135: 271-275.
4) Reiskind, Michael H., et al. "Nutrient-Dependent Reduced Growth and Survival of Larval *Culex restuans* (Diptera: Culicidae): Laboratory and Field Experiments in Michigan." J. Med. Entomol. 41 (4): 650-656 (2004).
5) Gerberg, Eugene J. Manual for Mosquito Rearing and Experimental Techniques. Amercian Mosquito Control Association, Inc. January 1970.