

LABORATORY STUDIES ON THE SIGNIFICANCE OF NaCl AS AN OVIPOSITION DETERRENT IN *CULISETA INORNATA*

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ABSTRACT. *Culiseta inornata* was tested for its ability to choose a salt-containing medium as an oviposition site that would allow complete development of eggs and larvae. Eggs were not laid at concentrations above 0.1 M NaCl. Egg and larval viability was tested at the same NaCl concentrations used in oviposition experiments. Eggs were viable at the same concentrations used by females for oviposition. More than 50% of the larvae failed to develop fully at concentrations above 0.01 M NaCl. *Culiseta inornata* may choose an oviposition site (relative to salinity) that ensures optimal egg hatching and not optimal larval viability.

INTRODUCTION

Female mosquitoes appear to be able to analyze the salinity which they may encounter at the oviposition site. Extensive studies by Woodhill (1938, 1941) indicated that *Culex quinquefasciatus* Say and *Aedes aegypti* (Linn.) could distinguish among different concentrations of salts, with *Cx. quinquefasciatus* not ovipositing above 1.7 M NaCl and *Ae. aegypti* depositing eggs inversely proportional to the concentration of salt below 3 M. *Aedes dorsalis* (Meigen) is known to prefer higher concentrations of NaCl than *Aedes nigromaculis* (Ludlow) (Petersen and Rees 1967). Wallis (1954) found that *Aedes polynesiensis* Marks and *Aedes pseudoscutellaris* (Theobald) preferred distilled water to media containing salt.

Wallis (1954) concluded that a given species would choose a larval breeding place within the restrictions for survival of that species. This hypothesis has not been adequately tested. One of the problems has been that the effect of salt on oviposition, egg viability and larval viability has seldom been examined on a single species and all of the aquatic stages of that species within the same study. The following research was designed to determine if all aquatic stages of *Culiseta inornata* (Williston) have the same tolerance to salt and whether the female will oviposit on media which will ensure complete development of the species.

MATERIALS AND METHODS

Mosquitoes used in this study were from a laboratory colony maintained at the University of Illinois for 5 years. Specimens were reared at 21°C as described by Pappas (1973). Females for these experiments were placed in plastic cages after taking a blood meal from a guinea pig. Humidity in the cages was maintained with wet paper towels. Adults had constant access to fresh apple slices. Four days after the blood meal, small glass containers with 50 ml of oviposition solution were randomly placed in the cages. Fluid levels were marked and

checked throughout the experiment. The oviposition containers were set in the cages in the evening and removed in the morning. If evaporation exceeded 5%, those experimental results were not used. Females usually laid eggs between the fourth and tenth day of the experiment. The oviposition test solutions were deionized water, 0.1 M, 0.05, M, 0.1 M and 0.25 M NaCl.

Larvae were reared in plastic shoe-boxes. Each container supported fifty larvae. One hundred larvae were tested at each concentration used in these experiments. Evaporation in larval containers was checked regularly but was of no consequence because each container had a lid. Larval skins were collected daily to determine rate of development. Dead specimens were counted and removed.

RESULTS

Fifty egg rafts were laid by 50 females during the oviposition phase of this experiment. This represented a total of 9255 eggs. All egg rafts were laid at concentrations below 0.25 M NaCl (Fig. 1). The largest percentage of rafts occurred on 0.1 M NaCl. The fewest number were laid on 0.01 M NaCl.

The egg rafts laid on the above media were transferred to individual containers with the same concentration of salt on which they were laid to determine the amount of hatching (Fig. 1). At concentrations of 0.1 M NaCl and below, the percent viability of eggs ranged from 78% to 85% with the largest percentage developing in deionized water. Another set of mosquitoes were allowed to oviposit on 0.1 M NaCl. After the tanning process was completed, the eggs were transferred to 0.25 M NaCl. Of the 543 eggs used, 39% hatched. Another 925 eggs which had been oviposited on 0.1 M NaCl were removed to 0.25 M while still white. None of these eggs hatched. These eggs also failed to complete tanning and remained gray-colored. The tanning process in *Culiseta inornata* is usually completed within 2 hr.

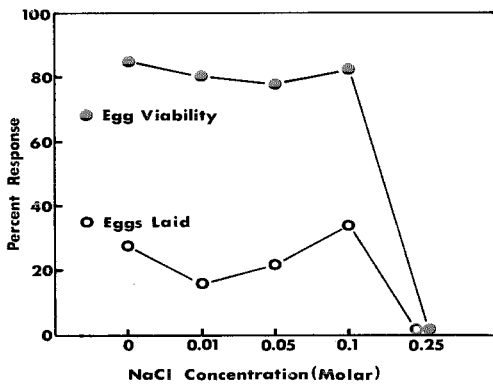


Fig. 1. Comparison of egg viability and the concentrations of NaCl in which egg-rafts were laid by female *Culiseta inornata*.

Larval development in deionized water was completed by day 18 and the adult stage was reached by day 23 (Fig. 2). Larval development was fairly synchronous up to the third instar with a high percentage of instar molts on the same day. Smaller percentages of instar molts/day began to occur at the fourth instar. No mortality was noted using deionized water as the larval medium.

The most prominent difference between deionized water and concentrations of NaCl was larval mortality. Less than 50% of the larvae reached the pupal stage at concentrations above 0.01 M. Larval mortality occurred progressively earlier in development with increasing concentrations of NaCl. The larvae in the 0.01 M NaCl test solution were the most successful at reaching the pupal stage. However, those reaching the pupal stage did not transform to adults; that portion of the experiment termi-

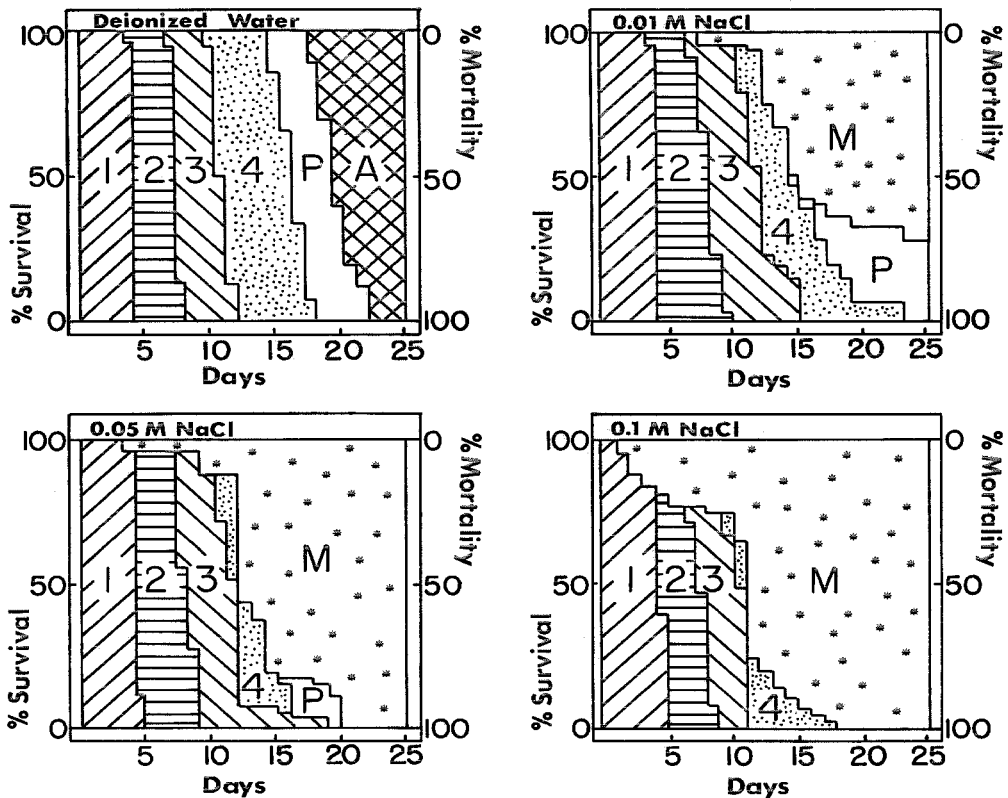


Fig. 2. Development of *Culiseta inornata* larvae in deionized water and test concentrations of NaCl. Numbers 1,2,3,4 are larval stages, P = Pupae, M = Mortality.

nated in 100% mortality. Not shown in Fig. 2 were tests on 50 larvae which were transferred to 0.25 M NaCl after hatching in 0.1 M NaCl. These larvae died by day 2 of the experiment.

DISCUSSION

As stated earlier, Wallis (1954) concluded that a female mosquito chose a larval breeding environment that would ensure the development of the species. Wallis' conclusion was based on comparisons of laboratory salt tolerance experiments and concentrations of salts where larvae were collected in nature. Lee (1973) came to the same conclusion with tests of sodium chloride on *Culiseta incidens*. The hypothesis presented by Wallis (1954) implies that egg and larval salt tolerances are the same. Our results question this implication. *Culiseta inornata* has egg and larval salt tolerances that are not the same. Egg viability was approximately the same from deionized water to 0.1 M NaCl while larvae developed completely only at lower concentrations of NaCl. Females oviposited on the same concentrations of NaCl which allowed complete egg development. Bailey et al. (1981) also considered the relationship between salinity, oviposition and egg-larval viability. In *Anopheles albimanus* Wied., eggs were laid at salt concentrations above that which larvae would fully develop. *Culiseta inornata* seems to oviposit on salt concentrations that ensure only viability of the eggs.

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