Short Communication

EFFECTS OF WATER SALINITY ON THE DEVELOPMENT AND SURVIVAL OF *AEDES AEGYPTI* AND *AEDES ALBOPICTUS*

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ABSTRACT

Background: *Aedes aegypti* and *Aedes albopictus* are important arbovirus vectors that transmit dengue, chikungunya and Zika. The present study shows the impact of increased salinity on the development and survival of these mosquitoes.

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Methods: The salinity tolerance of *Ae. aegypti* and *Ae. albopictus* eggs and larvae were investigated by measuring their mortality in response to salt concentrations ranging from 5 g/L to 50 g/L. Second instar larvae and three days old eggs were placed in glass bottle containing 250 ml of salt water. Each assay with fifty larvae was replicated three times for each species. The emerged adult wings length was measured for morphometric analysis.

Result: *Aedes aegypti* larvae showed survival as 100% at 5 g/L and in control, while 0% at 20 g/L. The survival rate of *Ae. albopictus* larvae was 62% at 5 g/L, 10% at 15 g/L and 0% at 20 g/L. The developmental period was from 6 to 7 days. The eggs immersed in salinity up to 20g/L hatched out within a maximum of 48hrs, and the highest hatching rate occurred in 5 g/L that is 75% and 57.14% for *Ae. aegypti* and *Ae. albopictus,* respectively.

Conclusion: Both *Ae. aegypti* and *Ae. albopictus* have the ability to breed and develop in brackish water, although, the survival and developmental rate decreased progressively with increased salinity.

Keywords: *Ae. aegypti, Ae. albopictus,* climate change, coastal area, salinity, sea level rise

INTRODUCTION

Aedes aegypti (L.) and *Aedes albopictus* (Skuse) mosquitoes are medically important species transmitting dengue, zika, chikungunya and yellow fever etc.[1] *Aedes aegypti* is the principal vector and *Ae. albopictus* is an important bridge vector in a unique habitat like Kerala.[2] These species were considered to inhabit clean urban freshwater environment in close proximity to humans, however, recent reports have shown that these two species can tolerate brackish waters.[3]

The urbanization and industrial development changed ecology and the breeding environmental conditions of these species in the coastal region owing to severe anthropogenic disturbances.[4,5] In Kerala, the coastal districts such as Alappuzha,

Kozhikode, Ernakulum, Kollam and Thiruvananthapuram have experienced worst dengue outbreaks.[6,7] The fresh water inhabiting mosquito species are capable of adapting to an expansion of brackish water habitats in coastal areas.[8,9] The present study is to determine the salinity tolerance of larvae of *Ae. aegypti* and *Ae. albopictus* and the viability of mosquito embryos when eggs are exposed to salt water.

MATERIAL AND METHODS

Effect of salt on the biological cycle:

Aedes aegypti and *Aedes albopictus* larvae (two to three days old 750 larvae) as well as three days old 150 eggs were immersed in salty water in glass bottles (250 ml). The salt concentrations tested were 0, 5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 g/L . The eggs and larvae which were placed in salinities from 30 -50 g/L did not hatch and develop so these data were excluded from the experiment. The salt solutions consisted of sea salt dissolved in deionized water. Sea salt (Sigma Aldrich, USA) was used to make up rearing solutions. Deionized water was used as control. Three replicates were considered for each concentration.

Morphometric analysis:

To assess changes, left wing of female mosquitoes obtained from exposure at different salinity was removed. A total of 170 wings were mounted using Hoyer's medium and examined under an Axioskop 40 compound microscope with Prog Res^{TM} C10^{Plus} software.

RESULTS

Aedes aegypti larvae showed 100% survival in 5 g/L as well as in control with developmental days of 6 and 7 respectively with 0% survival in 20 g/L. Larvae in 10 and 15 g/L showed a survival rate of 92% and 56% respectively (Fig. 1). Mortality occurred in 10 and 15 g/L around the time of pupation. In the context of *Ae. albopictus*, the survival rate was higher in control (90%) than 5 g/L (62%). In 15 g/L, great decline of survival (10%) was observed with 100% mortality in 20 g/L. (Fig. 1).

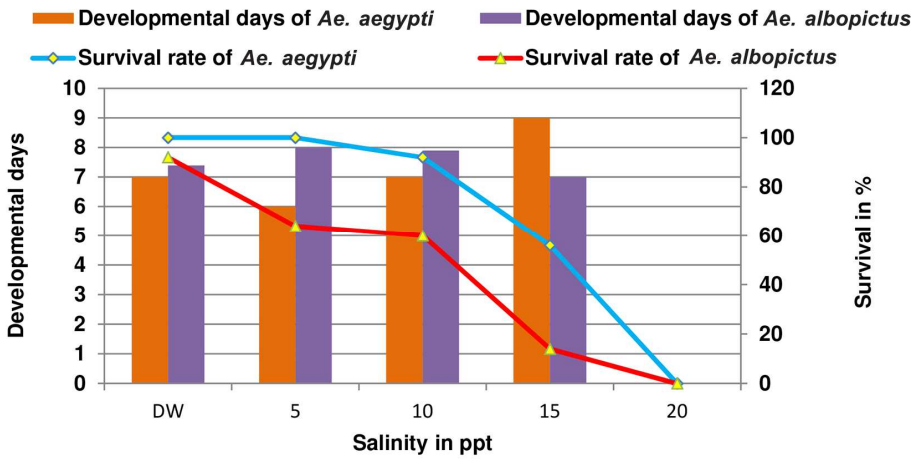

Fig. 1. Developmental days and survival rate of *Ae. aegypti and Ae. albopictus* larvae in various salinities.

The eggs immersed in salinities up to 20 g/L hatched out within a maximum of 48 hrs., and the highest hatching rate occurred in low salinities which was 75% in 5 g/L and only 48% in 20 g/L for *Ae. aegypti* and 57.14% in 5 g/L and 5.55% in 20 g/L for *Ae. albopictus*. In both species hatchability decreased as salinity increased. The eclosion periods of eggs of both species increased between 24 and 72 hours (Fig. 2).

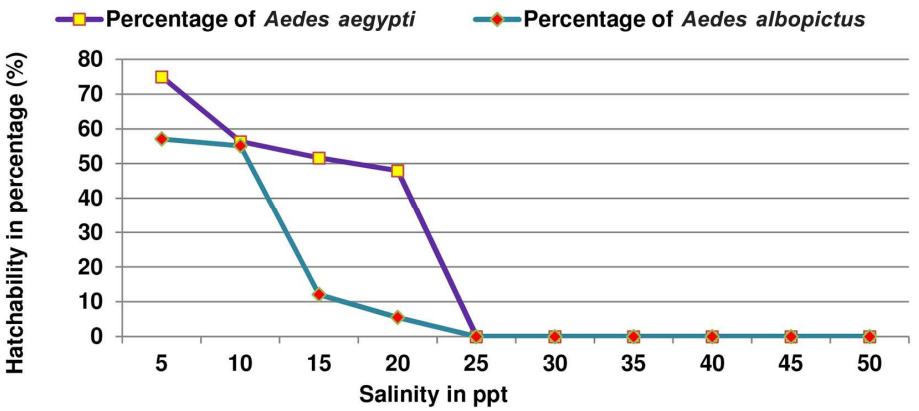

Fig. 2. Percentage of *Aedes aegypti* and *Aedes albopictus* eggs hatched out in various salinities.

The *Ae. aegypti* adult obtained from 5 g/L showed maximum wing length (4.34 mm). The adults collected from 15 g/L displayed minimum wing length (3.1 mm). This showed that the wing size decreased as the salinity increased (Fig. 3). A statistically significant correlation was observed between control group and 10 and 15 g/L salinity stressed groups ($p = 0.003$ and $p = 0.001$).

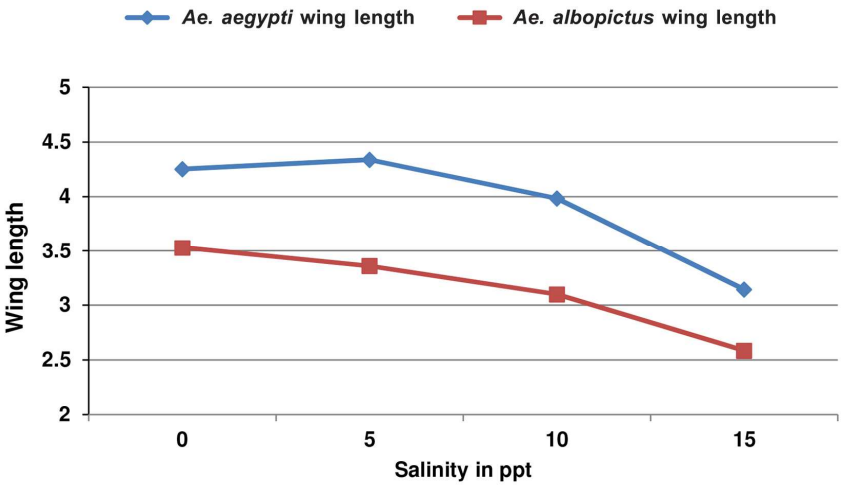

Fig. 3. Effect of salinity on wing length of *Aedes aegypti* and *Aedes albopictus.*

DISCUSSION

It is clear that *Aedes aegypti* and *Aedes albopictus* are able to tolerate a wide range of salinities. Our results show that *Ae. aegypti* and *Ae. albopictus* can undergo preimaginal stage development in saline water up to 15 g/L. For both the mosquito species larvae, the chances of surviving up to the adult stage decreased progressively with increased salinity. Mosquitoes are better adapted to brackish water because maximum wing length was observed for those mosquitoes which were reared in lower salinities (up to 5 g/L) however the wing size decreased as the salinity increased (10 -15 g/L) as observed in previous studies.[10] Brito-Arduino *et al.* (2010) and Ramasamy *et al.* (2011)[11,12] have reported that mosquito populations from coastal areas can be influenced by salt and possess certain adaptive processes to survive in the saline environment.

CONCLUSION

The results have shown that both the species are able to survive in salt concentrations of up to 15 g/L, indicating their better adaptive adjustment in the coastal areas. This warrants greater attention by public health systems to monitor disease incidence and preimaginal stage development of vector mosquitoes in artificial and natural coastal brackish or saline water habitats.

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Author contribution: RB – Work execution and principal investigator; ANV – Laboratory and field works; SS – Laboratory and field works; MDG – Review and editing.

Conflict of interest: The authors report no conflicts of interest.

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