Impact of Vertically-transmitted Dengue Virus on Viability of Eggs of Virus-Inoculated Aedes aegypti

by

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Abstract

Transovarial transmission (TOT) is known to occur in Aedes aegypti. This relationship carries tremendous epidemiological significance. The progeny of virus-inoculated Aedes aegypti were followed for seven generations to observe the impact of the virus on the viability of eggs and their rearing up to the adult stage. Dengue virus was found to exert an adverse effect on the viability of the eggs of the vertically-infected female mosquitoes and their larval and pupal stages up to adults when compared with the control population. While TOT ranged from 15.5% to 67.5% of the total mosquito populations in seven experimental generations, the corresponding adverse effect of the virus on eggs failing to hatch and grow into adults ranged from 30.0% to 68.1%.

Keywords: Transovarial transmission (TOT), dengue, Aedes aegypti.

Introduction

Dengue is endemic in South-East Asia where its more severe forms, dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), are major public health concerns. Owing to its complex epidemiology, the prevention of dengue/dengue haemorrhagic fever needs a great deal of research inputs for a better comprehension of its transmission dynamics. Of the various components responsible for dengue transmission, viz. mosquito, virus, man and environment, interactions between susceptible vectors and the virus have a direct bearing on the introduction and subsequent maintenance of dengue infection in a particular community. It has been reported by a number of workers from India, Myanmar and Nigeria that the transovarial transmission (TOT) of the dengue virus takes place across generations of Aedes aegypti. The virus, through this mechanism, has been recently demonstrated...
to persist in seven generations of the inoculated parent mosquitoes\(^{(7)}\). While the quantitative studies to determine the multiplication of the infected mosquitoes through TOT will have a direct relevance to the particular quantum of the disease in inhabiting susceptible human population, the study of the impact of the virus on the viability of the eggs of virus-carrying mosquitoes will add newer dimensions to our understanding of the host-parasite interactions in its cycle. The present paper deals with the results of an experiment concerning these aspects.

**Materials and methods**

The mosquitoes used in the present study were taken from a virus-free colony of *Aedes aegypti* which was being maintained in laboratory. Sixteen female mosquitoes were inoculated introthoracically (ITI)\(^{(8)}\) with DEN-3 virus strain (633978) obtained from the National Institute of Virology, Pune, India. 0.2 µl of viral suspension was inoculated and the transovarial transmission of the virus was studied in the adult progeny quantitatively for seven consecutive generations of *Aedes aegypti* in relation to its possible impact on the viability of eggs. At each generation the eggs laid by the experimentally-infected mosquitoes were counted and immersed into water. The virus transmitted vertically to the progeny was seen using the indirect fluorescence antibody test (IFA)\(^{(9)}\). In the experimental mosquito population the number of eggs, which failed to hatch and reach up to adult stages, were matched with the control group. Ambient temperature was maintained between 25-29°C and relative humidity between 80-85 percent.

**Results and discussion**

The table 1 shows the trend of the impact of the transovarily-transmitted virus on the viability of eggs and per cent reaching adult stages. The proportion of mosquitoes carrying the dengue virus, viewed in terms of its ability to lay viable eggs in the respective generation is presented in the table below.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Virus inoculated</th>
<th>Control</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>TOT in adults</td>
<td>Eggs to adult rearing</td>
</tr>
<tr>
<td></td>
<td>Examined</td>
<td>Positive</td>
</tr>
<tr>
<td>F1</td>
<td>50</td>
<td>26</td>
</tr>
<tr>
<td>F2</td>
<td>142</td>
<td>79</td>
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<td>F3</td>
<td>431</td>
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</tr>
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<td>F6</td>
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<td>6</td>
</tr>
<tr>
<td>F7</td>
<td>180</td>
<td>38</td>
</tr>
</tbody>
</table>

TOT = Transovarial transmission; ND = Not done

**Table.** Per cent viability of eggs of vertically-infected *Aedes aegypti* by DEN-3 virus in seven successive generations.
generations, showed a clear trend in F1 generation where 52.0% of TOT caused the failure of eggs reaching adult stage to the extent of 55.6%. In F1 controls, without the passage of virus led to an estimated failure to the extent of 4.3%. Similarly, in F2 when the proportion of the virus attained 55.6% TOT, the corresponding failure rate 30.0%, while in the F3 generation the failure rate (34.2%) was less than the proportion of TOT (55.6%). Again, in the F4 and F5 generations the adverse effect of the virus could be seen as almost in proportion with the percentage of adults carrying the vertically-transmitted virus. In the control group of mosquitoes failure rate of eggs reaching the adult stage was insignificant.

The transovarial transmission of dengue virus appears to support the fact that it is originally the virus of mosquitoes which has adapted to primates\(^4\). The TOT has also been seen in the present paper as a controlling factor over the reproductive potential of an invertebrate host undergoing this mechanism. The observations made while matching with the control group clearly indicated that the presence of the virus in the mosquito system had detrimental effects on the viability of the eggs laid.

The present observations indicate that through the transovarial passage the dengue virus persists in optimum number of individuals in the subsequent generations of the mosquito host. On the other hand, in this maintenance mechanism, TOT exerts a biological control over the population multiplication. Nevertheless, individuals sustaining the virus are the best-selected individuals by virtue of their genetic superiority. It is this population which is important in the transmission dynamics of the dengue virus. The retention of virus for its further sustenance in the community will depend on the host-parasite relationship taking place in this sustaining population under the prevailing environmental conditions. Furtherance of such studies with the inclusion of seasonal parameters with genetic and molecular-biological basis may lead to important details revealing basic research components.

**Acknowledgements**

The authors are grateful to Mr N. L. Kalra, Consultant Scientist, Malaria Research Centre, Delhi, for his valuable guidance and suggestions. The assistance rendered by Dr Manju Singhi, Technical Officer, and Dr Himmat Singh, Research Assistant, is thankfully acknowledged.

**References**


