Chapter-5

Influence of vegetation on the predatory performance of the instars of D. indicus
Influence of vegetation on the predatory performance of the instars of *D.indicus*

5.1 Introduction

Colonization in aquatic bugs gets influenced by the nature and abundance of vegetation. They show affinity to specific type of vegetation either for oviposition such as *Hydrilla* by *Ranatra* sp (Muthukrishnan, 1986) or for escape by clinging on to the adventitious roots of *Eichhornea* by *D.indicus* (Venkatesan, 1978). Control individuals that were kept without vegetation killed more prey than those with vegetation (Sankaralingam, 1990; Marin and Kumar, 2003). Like temperature, vegetation seems to play an important role in predation of water bugs.

Vegetation determines the occurrence of some species of dragonflies whose adults select certain plants for oviposition (Aoki, 1999). Ponds with more diversity of plants showed species richness than those with poor vegetation condition (De Marco *et al*, 1999). Savage (2000) has reported that species richness and its diversity showed significant positive correlation with the available vegetation in the habitat. Floating and submerged plants form an important element of the aquatic environment providing food and shelter for these insects. (Bisht and Das, 1980 and 1988).

Both emergent and submerged vegetation determine the distribution and abundance of free swimming invertebrates in any aquatic environment. The permanent ponds have more hydrophytes than temporary ponds. According to Gee *et al* (1997) new ponds are colonized by plants and invertebrates. According to Boyd (1997), and Wade and Stirling (1999 a and b), the pond topography, soil chemistry,
and the type of vegetation modify the distribution and colonization and dynamics of aquatic insects. The extent of aquatic vegetation increases in relation to the pond age, so that the dissolved oxygen level decreases with the cover of the water surface by floating plants in relation to pond size. (Gee et al 1997).

Habitat preference of aquatic hemipterans differ widely. Difference in size and nature of habitat and presence of dense aquatic vegetation are related to the population ecology of aquatic hemipterans. (Lemb and Maier, 1996). Vegetation density also influenced the spatial distribution of aquatic insects (Waitzbauer, 1976). Studies of Rao (1981) on the distribution of aquatic hemipterans in Coovum river showed that there was a perfect correlation between aquatic insect population and the presence of vegetation. Certain aquatic bugs show change in association with vegetation during development as in several species of water striders (Nummelin et al, 1984). A strong association with vegetation may be beneficial in habitats with fish population or detrimental in habitats with dense population of invertebrate predators associated with vegetation (Bennett and Streams, 1986). Warfe and Barmuta (2004) investigated the role of fresh water macrophytes as refuge by testing the hypothesis that the predators capture fewer prey in more dense and structurally strong habitats. They found that the habitat structure not only affects the prey capture success of a single predator in isolation but also the effectiveness of two predators combined particularly if it mediates interactions between the predators by using artificial plant analogues they found that structural complexity of the hydrophytes had a significant effect on the prey capture success of the predators.

Nymphs and adults of _M.lineatus_ showed a preference for a particular plant species. Choice of perch was influenced by the colour of perch, structure of
vegetation (vertical or horizontal) and position (surface or deep) and nature of perch (soft or hard) (Cloarec and Joly, 1988; Cloarec, 1982). According to Venkatesan et al (1995), the predatory performance of R.filiformis was significantly high in the absence of vegetation. This was true in *D. indicus* (Marin and Kumar, 2003). Further in *D.indicus* the general distribution of foraging tactics between active search and ambush is significantly influenced by the presence of perching sites. In the presence of vegetation predatory attempts included fewer dives and more attempts from ambush. The bugs were more active in the absence of vegetation (Cloarec, 1990). Sankaralingam (1990) reported that the predatory performance of *D.indicus* did not vary between sexes in the presence of vegetation. Short duration exposure of the predator to the prey in the presence of varied densities of vegetation did not show any rise or fall in the prey death rate. However, long duration of exposure causes effective changes with a decline in the prey death rate in the presence of varied densities of vegetation.

*D.indicus* is a highly versatile predator that forages both actively and from ambush. These bugs grasp prey items with their forelegs and then consume them by sucking. It captures the prey either from an ambush site under water or while swimming in the water column. Certain conditions enhance the stability of link between aquatic insect predators and the prey, (Peckarsky, 1982). Habitat structure provides not only the microenvironment for the prey to dwell but also indirectly influences the efficiency of the predator. The aim of the present study was to investigate the effect of varied densities of vegetation on the predatory efficiency of the instars of *D.indicus* and to evaluate the optimum density of vegetation for the mass rearing of *D.indicus*
5.2 Materials and methods

The encumbered males of *D. indicus* were collected from the Puthan pond, a permanent pond located about 25 km away from Kanyakumari. They were brought to the laboratory and maintained in glass aquaria with aged tap water. They were fed with the third size class larvae of *Culex* sp. The eggs were allowed to hatch and the I instar larvae were removed to the experimental glass containers of one litre capacity and maintained with one predator per container. The *Hydrilla* plant which was commonly found in the Puthan pond from where the predators were collected was used as the test vegetation. The containers with predators were provided separately with 0.5g, 1g, 1.5g, 2g, 2.5g and 3g of *Hydrilla*. Ten replicates were maintained for each one of the six densities of vegetation. The predators were exposed to a density of 50 third size class larvae of *Culex* sps and the number of dead prey items were replaced for every 12 hours and the density was always maintained at 50. The instars were reared till they became adults. The total number of *Culex* larvae fed by each group of predators at varied densities of vegetations for their entire developmental period were noted and tabulated. The stadial period of *D. indicus* reared in varied densities of vegetation was also noted and tabulated.

5.3 Result

The predatory performance of all the instars of *D. indicus* in six different quantities of vegetation was summarized and tabulated. (Table- 1 and Figure-1)

**0.5 g vegetation density**

In 0.5g vegetation category the I instar predated 11.6± 0.72 *Culex* larvae followed by 20.16 ± 0.72, 3016±0.72, 101.6±2.32 and 191.5±1.05 by II, III, IV and V instars respectively. The total prey intake by the instars during the entire
Table-1

Influence of vegetation on the mosquito predation by the instars of *D.indicus*

<table>
<thead>
<tr>
<th>Weight of vegetation (gram)</th>
<th>Mosquito larval predation by the instars (number)</th>
<th>Total prey intake (number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>0.5</td>
<td>11.6±0.72 a</td>
<td>20.16±0.72 a</td>
</tr>
<tr>
<td></td>
<td>354.42±4.72 a</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>13.2±0.62 a</td>
<td>29.8±1.48 a</td>
</tr>
<tr>
<td></td>
<td>310.6±2.48 a</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>13.16±0.72 a</td>
<td>26.0±1.28 a</td>
</tr>
<tr>
<td></td>
<td>337.64±2.72 a</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>13.5±1.05 b</td>
<td>40.16±1.72 b</td>
</tr>
<tr>
<td></td>
<td>388.16±2.32 b</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>11.6±0.72 a</td>
<td>30.3±0.6 a</td>
</tr>
<tr>
<td></td>
<td>364.2±2.12 a</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11.6±0.72 a</td>
<td>30.16±0.72 a</td>
</tr>
<tr>
<td></td>
<td>330.22±4.72 a</td>
<td></td>
</tr>
</tbody>
</table>

Means followed by the same alphabet across a column are not statistically significant at 0.05% by one way classification (ANOVA).
Figure-1 Influence of vegetation on mosquito predation by the instars of *D.indicus* at 0.5-3 g vegetation density

![Graph showing the influence of vegetation on mosquito predation by the instars of *D.indicus* at different vegetation densities.](image)

Figure-2 Influence of vegetation on stadial period of *D.indicus* at 0.5-3 g vegetation density

![Graph showing the influence of vegetation on the stadial period of *D.indicus* at different vegetation densities.](image)
developmental period from I instar to adult in 0.5g vegetation density category was 354.42±4.72 *Culex* larvae.

**1 g vegetation density**

In 1g vegetation category I instar predated 13.2±0.62 *Culex* larvae followed by 29.8±1.48, 41.0±0.12, 56.3±0.60 and 170.5±1.05 by II, III, IV and V instars respectively. The total prey intake by the instars during the entire developmental period from I instar to adult in 1g vegetation density category was 310.6±2.48 *Culex* larvae.

**1.5 g vegetation density**

In 1.5g vegetation category I instar predated 13.16±0.72 *Culex* larvae followed by 26.0±1.28, 38.16±0.72, 62.16±0.52, 198.16±0.72 and 198.16±0.72 by II, III, IV and V instars respectively. The total prey intake by the instars during the entire developmental period from I instar to adult in 1.5g vegetation density category was 337.64±2.72 *Culex* larvae.

**2 g vegetation density**

In 2g vegetation category I instar predated 13.5±1.05 *Culex* larvae followed by 40.16±1.72, 41.0±0.82, 75.5±1.05 and 218.6±5.62 by II, III, IV and V instars respectively. The total prey intake by the instars during the entire developmental period from I instar to adult in 2g vegetation density category was 388.16±2.32 *Culex* larvae.

**2.5g vegetation density**

In 2.5 g vegetation category, I instar predated 11.6±0.72 *Culex* larvae followed by 30.3±0.60, 38.8±1.48, 78.8±1.48 and 204.5±1.05 by II, III, IV and V
Table-2

**Influence of vegetation on the stadial period of *D.indicus***

<table>
<thead>
<tr>
<th>Weight of vegetation (gram)</th>
<th>I-II</th>
<th>II-III</th>
<th>III- IV</th>
<th>IV- V</th>
<th>V- Adult</th>
<th>Total stadial period(days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>5.3±0.24</td>
<td>6.16±0.72</td>
<td>4.16±0.24</td>
<td>11.6±0.85</td>
<td>13.33±1.86</td>
<td>40.55±3.12</td>
</tr>
<tr>
<td>1</td>
<td>5.3±0.4</td>
<td>6.5±0.27</td>
<td>6.16±0.27</td>
<td>5.3±0.18</td>
<td>10.3±1.08</td>
<td>32.56±2.95</td>
</tr>
<tr>
<td>1.5</td>
<td>5.16±0.42</td>
<td>6.5±0.59</td>
<td>5.42±0.38</td>
<td>7.5±0.63</td>
<td>10.33±1.22</td>
<td>34.65±3.08</td>
</tr>
<tr>
<td>2</td>
<td>5.3±0.34</td>
<td>6.16±0.32</td>
<td>4.3±0.22</td>
<td>9.5±0.82</td>
<td>9.16±0.96</td>
<td>34.42±3.22</td>
</tr>
<tr>
<td>2.5</td>
<td>5.16±0.49</td>
<td>6.3±0.3</td>
<td>5.16±0.38</td>
<td>6.5±0.56</td>
<td>12.83±1.26</td>
<td>35.95±3.68</td>
</tr>
<tr>
<td>3</td>
<td>5.16±0.36</td>
<td>4.3±0.24</td>
<td>6.3±0.47</td>
<td>5.16±0.42</td>
<td>15.5±1.86</td>
<td>36.42±4.62</td>
</tr>
</tbody>
</table>
Figure-3 Regression analysis depicting the relation between the number of larvae predated by the instars of *D.indicus* in 2 gram density vegetation.

\[ y = 44.56x - 55.91 \]

\[ R^2 = 0.7425 \]
The total prey intake by the instars during the entire developmental period from I instar to adult in 2.5g vegetation density category was 364.2±2.12 Culex larvae.

3 g vegetation density

In 3g vegetation category I instar predated 11.6±0.72, Culex larvae followed by 30.16±0.72, 43.0±0.82, 48.3±0.66 and 197.16±0.72 by II, III, IV and V instars respectively. The total prey intake by the instars during the entire developmental period from I instar to adult in 3g vegetation density category was 330.22±4.72 Culex larvae.

Vegetation density on stadiial period

The present study on the influence of vegetation density on the duration of stadiial period showed that the maximum stadiial period was in 0.5 g density vegetation category (40.55±3.12 days) followed by 3 g density vegetation (36.42±4.62). The lowest stadiial period was noted in the 1 g vegetation category. However, the stadiial period in 1g, 1.5g and 2g vegetation categories did not show significant deviation (Table-2 and Figure-2).

The data were subjected to one way classification ANOVA (Table-1). Regression analysis showed a positive relationship between the number of Culex larvae predated by the instars of D.indicus in 2g density vegetation (Figure-3).

5.4 Discussion

Habitat preference by aquatic hemipterans differ widely. Differences in size and nature of habitat, presence of dense aquatic vegetation are related to the ecology of the population of aquatic hemipterans. Aquatic hemipterans show an affinity to a
specific type of vegetation either for escape by clinging to the roots of *Eichhornea* as seen in *Diplonychus* sp (Venkatesan, 1978) or for oviposition (Muthukrishnan, 1986). Chandra Mohan (2002) reported that the predatory rate of *D. indicus* decreased in the presence of *Eichhornea* or *Hydrilla* or in combination of both.

Cloarec (1990) reported that in *D. indicus*, the presence of perching sites significantly influenced the general distribution of foraging tactics between active search and ambushing and that in the absence of perching sites, bugs were significantly more active and in the presence of vegetation predatory attempts included fever dives and more attempts from ambush. Studies of Bennet and Streams, (1986), on the density and distribution of Notonectids in relation to vegetation, reported that a strong association with vegetation may be beneficial in habitats with fish population or detrimental in habitats with dense population of invertebrate predators associated with vegetation. Vegetation may affect predation in aquatic insect in 2 ways.

1. It may provide refuge for prey (Cook and Streams, 1984)

2. It adds structural complexity, which may reduce foraging rates. (Crowder and Cooper, 1982). Species inhabiting aquatic vegetation reduce their risk of predation by fish and they may simultaneously increase their risk of predation by Odonates and Nepids associated with vegetation. Predation strategy is a very important factor in habitat selection, (Giller and Mc Neill, 1981). They reported that perch sites had a planned edge and are particularly used by ‘Sit and Wait’ predators such as such as *Notonecta glauca, N.obliga* and *N.maculata*, since, they allow greater opportunity to monitor the water and launch an attack. Such a use of perch site is also reported earlier in flies (Oldroyd, 1964).
Earlier works of Sankaralingam (1990) and Vanitha (1999), revealed that both male and female Belostomatids exhibited a decline in the predatory performance in the presence of varied densities of vegetation. This was true in *Anisops bouvieri*, a predator with active search. (Nishi and Venkatesan 1997). They showed that there was not much difference between the male and female predators in the presence or absence of vegetation. They also showed that vegetation inhibits the predatory performance of *A.bouvieri*. Marin and Kumar, (2003) also found a similar observation in *D.indicus*. They found that vegetation hinders the predatory performance of *D.indicus* on mosquito larvae. The predator killed more prey in the absence of vegetation when compared to those in the presence of vegetation. Females were found to be efficient in prey capture than males.

Studies on the influence of vegetation density on mosquito predation by instars of *D.indicus* revealed the fact that the predatory rate of all the instars were uniformly higher when they were reared in 2 g vegetation density. Further the present study revealed that the V instar of *D.indicus* showed the maximum predation in all the vegetation densities. But in 2 g vegetation density the feeding was maximum and was found to be the ideal density.

Studies of Sankaralingam,(1990) on the predatory performance of *D.indicus* showed that short duration exposure of the predator to the prey in the presence of varied densities of vegetation did not show any significant rise or fall in prey death. However long duration of exposure causes effective changes in predatory performance.

The present investigation showed the influence of vegetation on the predatory efficiency of the various instars of *D.indicus* and the ideal vegetation
density being 2 gram per litre of water which may form the basis for developing the strategy for mass culturing *D. indicus* for biological control operations concerning mosquito larvae.