Diel variations in zooplankton populations in mangrove ecosystem at Gaderu canal, southeast coast of India

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To determine this energy flow 24 hours cycles were carried out in the Gaderu river which flows through dense mangrove vegetation. The day time planktonic composition was rich with phytoplanktonic community and detritus, which is the main source of food for the organisms living in the mangrove ecosystem. The temperature and salinity reflected the conditions of the bay while the plankton had direct relationship with the nature of tide, strength of the current and direction of flow. Higher displacement volumes of about 0.75, 0.75, 0.85 ml.m$^{-3}$ were recorded during night with numerical abundance of 27053, 17401 and 18688 no.m$^{-3}$ respectively. The detritus constituted about 50-60% during the low tide period. Among the zooplankton, copepods and larvae of molluscs and polychaetes contributed to the bulk of zooplankton component. In spite of the fluctuating currents, regular diurnal rhythm was observed for many of the holoplanktonic and meroplanktonic forms.

In recent years studies on coastal zone management has drawn the attention of many scientists, where mangrove ecosystem plays an important role. In order to study the hourly changes in the diversity and distribution of zooplankton, collection of samples were undertaken during one tidal cycle lasting for 24 hrs in the month of June'95 in Gaderu canal which is the main receptacle for all the influx of nutrients from the surrounding mangrove swamps. The present study which was undertaken for the study of zooplankton populations in the mangrove environment revealed information regarding the fluctuating hydrographical parameters which act as limiting factors, which in turn influence the diversity and distribution of zooplankton. Similar studies on the abundance and distribution of the zooplankton populations were made in the Pitchavaram mangroves$^1$, mangrove habitats of Goa$^2$.

Surface zooplankton and water samples were collected at intervals of three hours at a fixed point in the middle of the Gaderu canal (lat. 82°12'-82° N and long. 16°31'-16°54') . Maximum depth encountered was 3.5 m. The sampling started at 0900 hrs of 24-6-1995 and continued till 0900 hrs of 25-6-1995. The present study was carried out in the month of June when highly stable hydrographical conditions prevail with high plankton diversity. Surface temperatures were recorded directly with a thermometer. Secchi disc was employed for measuring the transparency. Hellige's turbidity meter was employed for turbidity, and expressed in ppm$^3$. Dissolved oxygen was estimated by Winkler's method$^4$, chlorinity by standard titration method of Knudsen, and the corresponding salinity calculated from Knudsen's tables$^5$. Zooplankton samples were collected using 40 cm diameter net of 120μm mesh size and fixed in 5% formaldehyde$^6$. For the quantification of the zooplankton a TSK flow meter was fixed at the opening of the net. Biomass was estimated by displacement volume$^6$. For numerical analysis the plankton was sorted out and individual groups were counted and expressed as no.m$^{-3}$ with flow meter readings.

Maximum surface water temperature recorded was 30°C at 1800 hrs during high tide on 24-6-95 and the least was 29°C at 0900 hrs during mid high tide on 24-6-95. The surface water salinity ranged from a maximum of 30.21×10$^{-3}$ during mid low tide at 1500 hrs on 24-6-95 to a minimum of 16.55×10$^{-3}$ during mid high tide at 0900 hrs on 25-6-95. The surface water pH ranged from a maximum of 7.24 during mid high tide at 0900 hrs to a minimum of 6.8 during mid low tide at 1500 hrs on 24-6-95. Turbidity of surface water ranged from a maximum of 22 ppm during high tide period to a minimum of 17 ppm during low tide period (Table 1).
Table 1—Zooplankton displacement volume and numerical abundance along with the hydrographical parameters during 24 hours

<table>
<thead>
<tr>
<th>Time (hrs)</th>
<th>Tide</th>
<th>Seechi disc (cm)</th>
<th>Temp. (°C)</th>
<th>D.O (ml.1⁻¹)</th>
<th>Salinity (x10⁻²)</th>
<th>Turbidity (ppm)</th>
<th>Biomass (ml.m⁻³)</th>
<th>Numerical abundance (no.m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0900</td>
<td>MHT</td>
<td>75</td>
<td>29.0</td>
<td>4.48</td>
<td>27.72</td>
<td>22</td>
<td>0.13</td>
<td>9379</td>
</tr>
<tr>
<td>1200</td>
<td>LT</td>
<td>45</td>
<td>29.4</td>
<td>4.70</td>
<td>31.21</td>
<td>21</td>
<td>0.29</td>
<td>15863</td>
</tr>
<tr>
<td>1500</td>
<td>MLT</td>
<td>65</td>
<td>29.8</td>
<td>5.09</td>
<td>30.21</td>
<td>17</td>
<td>0.30</td>
<td>12376</td>
</tr>
<tr>
<td>1800</td>
<td>HT</td>
<td>60</td>
<td>30.0</td>
<td>5.06</td>
<td>22.38</td>
<td>21</td>
<td>0.50</td>
<td>19630</td>
</tr>
<tr>
<td>2100</td>
<td>MHT</td>
<td>-</td>
<td>29.4</td>
<td>5.43</td>
<td>24.33</td>
<td>22</td>
<td>0.73</td>
<td>27053</td>
</tr>
<tr>
<td>0000</td>
<td>LT</td>
<td>-</td>
<td>29.4</td>
<td>4.64</td>
<td>26.47</td>
<td>21</td>
<td>0.75</td>
<td>17401</td>
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<tr>
<td>0300</td>
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<td>-</td>
<td>28.8</td>
<td>4.70</td>
<td>24.49</td>
<td>22</td>
<td>0.85</td>
<td>18668</td>
</tr>
<tr>
<td>0600</td>
<td>HT</td>
<td>105</td>
<td>29.9</td>
<td>4.76</td>
<td>17.09</td>
<td>18</td>
<td>0.23</td>
<td>9612</td>
</tr>
<tr>
<td>0900</td>
<td>MHT</td>
<td>120</td>
<td>29.4</td>
<td>4.81</td>
<td>16.55</td>
<td>17</td>
<td>0.20</td>
<td>12528</td>
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<tr>
<td>Mean</td>
<td></td>
<td>78</td>
<td>29.45</td>
<td>4.85</td>
<td>24.49</td>
<td>20</td>
<td>0.44</td>
<td>15834</td>
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<tr>
<td>SD</td>
<td></td>
<td>28.57</td>
<td>0.39</td>
<td>0.29</td>
<td>5.17</td>
<td>2.14</td>
<td>0.27</td>
<td>5635.05</td>
</tr>
</tbody>
</table>

The sampling started (0900 hrs on 24-6-96) corresponding to mid high tide period and the depth was about 2.9 m, and the maximum depth was noticed during high tide period i.e., about 3.5 m. Because of the receding water from adjacent smaller creeks even during low tide there is not much variation in the depth. Surface water dissolved oxygen values ranged from a maximum of 5.43 ml.1⁻¹ during high tide at 1800 hrs on 24-6-95 to minimum of 4.48 ml.1⁻¹ during mid high tide period at 0900 hrs.

Zooplankton biomass values ranged from a maximum of 0.85 ml.m⁻³ during mid low tide at 0300 hrs on 25-6-96 to minimum of 0.13 ml.m⁻³ during mid high tide at 0900 hrs of the day on 24-6-95. Numerical abundance of zooplankton ranged from a maximum of 27,053 no.m⁻³ during mid high tide at 2100 hrs during night on 24-6-95 to a minimum of 9,379 no.m⁻³ during mid high tide at 0900 hrs in the morning of 24-6-95, as reported earlier from the Pullavazhi brackish waters⁷.

The present study revealed information regarding the fluctuating hydrographical parameters which influence the plankton diversity and distribution. The salinity which is the main physical parameter that can be attributed to the plankton diversity act as a limiting factor which influence the planktonic community and its distribution⁸. Generally the salinity will be high during the high tide and low during the low tide. But in this observation the low tide waters also have higher salinity than the high tide waters.

Similar observation of higher saline low tide waters was reported earlier from the Zuari river Goa⁹. The rise in the salinity is attributed to the physiographic charcteristics of the estuary¹⁰.

The zooplankton biomass (ml.m⁻³) and total zooplankton numbers (no.m⁻³) reveal that the night samples taken during 2100 hrs to 0300 hrs have higher values and this particular observation once again recalls the diurnal vertical migration of the zooplankton community. The species diversity and the plankton composition was also high during the dark hours of the sampling. Similar trend was noticed in the diel variation studies from the Vellar estuary¹¹, Godavari estuary¹², and the Mandovi estuary¹³.

Zooplankton diversity was relatively high. Among the meroplankton mention may be made of the decapod larvae, naupli and copepodid stages of various crustaceans which were fairly abundant during the day time samples. Decapod larvae like mysis, megalopa were observed fairly in good numbers in the samples collected during dark hours. Both the gastropod and bivalve veligers were seen during night samples and their number was fairly high during the night than that of the day. Similar observations were made in the diel variations studies in the Coleroon estuarine complex¹⁴. Copepod species of Paracalanus parvus, Eucalanus elongatus, Acrocalanum gibber, Centropages furcatus, Acartia erythrae, Corycaeus speciosus, Macrosetella gracilis, Eutusperpina acutifrons were recorded. Copepodid
stages outnumbered the adult copepods during the day and the reverse trend was observed in the night samples. The other groups which were represented by siphonophores, ctenophores, polychaete larvae, chaetognaths, amphipods, cladocerans and fish larvae were seen in few numbers sporadically. Mention may be made of the postlarval stages of shrimps which were fairly abundant during night samples (about 50 to 80 per net haul). The mangroves are the nurseries for the shrimps and also the other benthic organisms dwelling in the estuary. The day samples were rich of the nauplii and zoeae stages as reported from the Mandovi estuary.

The physiographical conditions and flow characteristics of Gaderu are very interesting in the sense that the Gaderu canal is open at both ends, one into the Kakinada Bay and and the other end in the proximity of the opening of the Gouthami Godavari into the Bay of Bengal. The canal Gaderu is subjected to the influence of tides from both ends and in addition it receives drainage from innumerable creeks all along its length. On account of these physiographical conditions the hydrobiological conditions in the mangrove ecosystem undergo rapid changes and the populations living in such a situation exhibit wide toleration to euryhaline conditions. In spite of these variations certain amount of endemism is noticed in the faunal characteristics. The survival and distribution of these organisms obviously depend on certain behavioural aspects like diurnal vertical migration which is the universal phenomenon often exhibited by the zooplanktonic communities.

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