RELATED PUBLICATION
BIODIVERSITY, ECOLOGY AND CONSERVATION OF MANGROVES IN DEVBAGH CREEK OF KALI ESTUARY NEAR KARWAR, KARNATAKA, INDIA

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ABSTRACT: Devbagh creek in Kali estuary near Karwar came to light with starting of a resort alongside by Jungle Lodges of Forest Department. As it was found to be rich in floral content, a systematic study was undertaken to record the biodiversity and ecology of the mangrove phytes. A qualitative study of faunal members of the creek was limited to only listing. Towards conservation of mangroves, in association with forest department certain mangrove seedlings were raised. These seedlings were transplanted in the creek with moderate success. The result of the present work shows a high degree of biodiversity and salt tolerance by the mangrove phytes in the creek. Solid waste pollution by tourists and felling of trees by villagers are the likely threats to the creek. In view of its closeness to the town and Jungle Resort that attracts tourists from India and abroad, suitability of this scenically unique creek in declaring as a mangrove Bio-Reserve/Marine park is suggested.

Key words: Devbagh Creek - Kali Estuary - Mangrove Biodiversity - Conservation - Marine park

INTRODUCTION

The distribution of mangrove forests in the world is known to coincide with the 20°C Summer Isotherm Line (Duke N.C., 1991). The total cover of mangroves in India is estimated at about 819 sq.km [Sidhu S.S.1963]. About 80% of the Indian mangroves are present on the East Coast and the Andaman and Nicobar group of islands (Snedakar and Snedakar, 1984). The rest is present on the West Coast and a small percentage on the Lakshwadeep group of islands.

Karnataka coast on the western boundary of India has about 9 major rivers and a few more minor rivers that meet the Arabian Sea. According to an estimate Karnataka has about 50 sq.kms. of mangrove cover composed of 14 species belonging to 9 genera under 7 families (Untawale A.G. and Wafar, S., 1986).

Mangrove ecosystem is an open ecosystem, which is sustained by flow of energy and nutrients from marine and land drainage, that in turn affects or influences these ecosystems (Govindaswamy et. al., 1987). Mangroves are one of the biologically diverse ecosystems in the world. As this ecosystem is rich in organic matter and nutrients, it supports very large biomass of flora and fauna. Therefore, mangroves are amongst one of the most productive ecosystems in the tropics (Robin L.E. and Bazelevic N.I., 1966).

Nowadays almost every estuary and backwater is being commercialised either by construction of salt pans, aquaculture ponds or going in for land reclamation for building and other anthropogenic activities. Some of these activities associated with mangrove ecosystem are indiscriminate tree felling, sand and shell mining land encroachment for agricultural and horticulture purpose, unscientific and indiscriminate fishing, disposal of domestic and industrial wastes etc.

These problems cannot be nullified but atleast the intensity with which it is carried out needs to be taken care off. Even though almost all the estuaries these days are prone to large-scale anthropogenic activities. There are still some mangrove regions or ecosystems that face less threat if not any at all from human activity as in the present case study of an unique undisturbed hitherto unreported habitat of mangroves at the Devbagh creek right at the mouth of river Kali in Karwar, Karnataka.

Focus of the present work was to study the floral biodiversity, some hydrological parameters and listing of the observed faunal members and threat of pollution by solid waste dumping.

STUDY AREA

The study area selected for the present work is a tidal creek present on the north bank of the mouth of river Kali, at Devbagh, Karwar of Uttara Kannada district in Karnataka. Rao and Suresh (2001) while dealing with Kali estuary in their book, 'Coastal Ecosystems of the Karnataka state, India, I. Mangroves' show village Devbagh wrongly on the right bank of Mavina halla (p.184) whereas it is actually on the left bank. Also, the creek under present consideration is shown as a mudflat (p.276).

The Devbagh creek is located amidst Casuarina plantation in the village of Devbagh. This creek is located at a distance of about 2 kms. from the nearest human habitation the Devbagh village. The geographic position of the mouth of this creek lies between 14°50.692’N, 74°07.208’E and 14°15.720’N 74°07.318’E. The total area of the creek is about 6.6 hectares and the linear length of the creek is about 764mt during spring low tides.
This particular creek was chosen for the present study as it happens to be a new found mangrove habitat and no research work of any sort was carried out on this creek. The creek was exposed to very limited anthropogenic activity such as minimum solid waste dumping by tourists. The only other human activity visible in this creek was small-scale self sustenance fishery carried out by village fishermen. The place is accessible by motorboat or trek through Casuarina plantation or along the sea beach from the village.

**METHODOLOGY**

Initially, with the help of survey equipments extent of the creek was measured [map 1]. Mangrove vegetation was studied by using Quadrat method as described in Shukla and Chandel (1972). These quadrats of 100 sq.m. each were placed in a direction at right angles to the creek at various heterogeneous sites, during the study period of 2001-2002. The parameters noted in each Quadrat are as follows:

1. Total number of species present.
2. Total number of plants belonging to each species present.
3. Girth of each plant at breast height i.e. 1.3m above the ground level was noted and used to calculate diameter.

To characterize the floristic community as a whole certain numerical figures called Parameters are used to give a clear picture of the community structure. The various parameters that were used in the present study were 1. Density 2. Frequency 3. Basal Area Per Tree and 4. Abundance. The relative values of Density, Frequency and Dominance were calculated from the above initial three parameters respectively. The Importance Value Index (IVI) was also calculated. All the above parameters were determined following Shukla and Chandel (1972).

Faunal composition was studied in the exposed part of the creek by observations and also, with the help of dragnets. The faunal studies were only qualitative in nature.

Limited Environmental parameters such as temperature, salinity, pH and dissolved oxygen of water; sediment temperature and pH; and soil characteristics were studied.

**FLORAL STUDIES**

In all 27 species of mangrove phytos and associated plants are recorded. Since some of these were present in insignificant numbers, only plants that were present in statistically significant number were analysed for their community structure. The present study revealed that in this creek there were a total of 19 species of plants in significant number, including 14 species of eumangroves belonging to 7 families and remaining 5 species were of associate flora belonging to 5 different families. The distribution of mangrove plants was in thick patches all along the length of the creek.
OBSERVATIONS AND RESULTS

Environmental parameters:

The following variations were found in different environmental parameters recorded during the study period at the Devbagh Creek.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average Min.</th>
<th>Average Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air temperature</td>
<td>24.5 °C</td>
<td>33.0 °C</td>
<td>28.8 °C</td>
<td>29.9 °C</td>
</tr>
<tr>
<td>Water temp.</td>
<td>27.0 °C</td>
<td>37.0 °C</td>
<td>29.9 °C</td>
<td>34.0 °C</td>
</tr>
<tr>
<td>Sediment temp.</td>
<td>26.0 °C</td>
<td>35.0 °C</td>
<td>29.0 °C</td>
<td>31.0 °C</td>
</tr>
<tr>
<td>Water Salinity</td>
<td>0.0 PPT</td>
<td>32.0 PPT</td>
<td>13.3 PPT</td>
<td>20.16 PPT</td>
</tr>
<tr>
<td>D.O. in Water</td>
<td>6.12 mg/l</td>
<td>7.82 mg/l</td>
<td>6.37 mg/l</td>
<td>7.63 mg/l</td>
</tr>
<tr>
<td>Suspended load of Water</td>
<td>0.08 gm/l</td>
<td>0.76 gm/l</td>
<td>0.24 gm/l</td>
<td>0.33 gm/l</td>
</tr>
<tr>
<td>Water pH</td>
<td>5.6</td>
<td>7.93</td>
<td>6.97</td>
<td>7.39</td>
</tr>
<tr>
<td>Sediment pH</td>
<td>5.8</td>
<td>8.8</td>
<td>6.16</td>
<td>8.5</td>
</tr>
<tr>
<td>Sand fraction</td>
<td>38.36%</td>
<td>86.86%</td>
<td>49.03%</td>
<td>81.14%</td>
</tr>
<tr>
<td>Silt</td>
<td>10.17%</td>
<td>41.24%</td>
<td>13.59%</td>
<td>38.46%</td>
</tr>
<tr>
<td>Clay</td>
<td>1.12%</td>
<td>20.4%</td>
<td>2.38%</td>
<td>12.66%</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>1.24%</td>
<td>4.52%</td>
<td>1.68%</td>
<td>3.82%</td>
</tr>
</tbody>
</table>

Family-wise list of plants recorded is as follows:

Exclusive Mangrove Species:

Family: Rhizophoraceae
- *Rhizophora mucronata* Lamk.
- *Rhizophora apiculata* Blume.
- *Kandelia candel* [L.] Druce
- *Bruguiera cylindrica* [L.] Bl.
- *Bruguiera gymnorrhiza* [L.] Lamk.

Family: Avicenniaceae
- *Avicennia alba* Bl.
- *Avicennia marina* Stapf & Mold
- *Avicennia officinalis* L.

Family: Sonneratiaceae
- *Sonneratia alba* J. Smith

Family: Acanthaceae
- *Acanthus ilicifolius* L.

Family: Combretaceae
- *Lumnitzera racemosa* Willd.

Family: Myrsinaceae
- *Aegiceras corniculatum* Blanco

Family: Euphorbiaceae
- *Excoecaria agallocha* [L.]

Associated floral members:

Family: Verbenaceae
- *Clerodendrum inerme* Gaertn.

Family: Fabaceae
- *Derris trifoliata* Lou.
- *Erythrina indica* Lam.

Family: Alzioaceae
- *Sesuvium portulacnotrum* L.

Family: Convolvulaceae

Family: Malvaceae

Family: Salvadoreae
- *Salvadora persica* L.

Family: Cyperaceae
- *Scirpus littoralis* Schred.

Family: Gutiferae
- *Calophyllum inophyllum* L.

Family: Apocynaceae
- *Rawuolfia tetraphylla*

Family: Casuarinaceae
- *Casuarina equisetifolia* L.

Family: Poaceae

*Scientific names as per Naskar K. and Mandal R., [1999] Community Structure (Table 1 & 2)

Family Dominance

Among the eumangroves the most dominant family was Rhizophoraceae represented by 5 species belonging to 3 genera. This was followed by Avicenniaceae represented by 3 species all belonging to a single genus *Avicennia*. Sonneratiaceae was the third dominant family represented by 2 species belonging to a single genus *Sonneratia*. All the other 4 families viz: Acanthaceae , Combretaceae, Euphorbiaceae and Myrsinaceae were represented by plants of a single genus and a single species. The associated mangrove flora were represented by 5 families each with a single genus and species.

Basal Diameter Class [BDC]

Basal Diameter of only 13 out of the 14 eumangrove plants could be determined [except *Acanthus ilicifolius*]. The plants were grouped into 7 BDCs. *Avicennia marina* was the only plant to be represented in 6 of the 7 BDCs. *A. alba, A. officinalis* were found to belong to 5 out of the 7 BDCs, followed by *Lumnitzera racemosa* belonging to 4 of the 7 BDCs.
Rhizophora apiculata and R. mucronata, Bruguiera cylindrica and Sonneratia caseolaris were found in the first three BDCs, while Kandelia candel and Aegiceras corniculatum were found in only 1 of the 7 BDCs.

Density (n/10 sq.m.), Basal Area Per Tree (BA/T), Frequency (%), & Abundance (n/100 sq. m.): Aegiceras corniculatum had the highest Density of 1.39 n/10 sq.m., followed by A. illicifolius with 0.84 n/10 sq.m. The next dense distribution was observed in case of A. officinalis with 0.67 n/10 sq.m. In terms of BA/T measured in sq.m, A. marina had the highest of 1.7824 sq.m., the second highest was A. alba, followed by S. alba. Frequency of A. marina was highest i.e. 90% followed by A. corniculatum with 80%, third place was occupied by A. alba, A. officinalis and L. racemosa with a frequency of 70% each. Lowest frequency of 10% was recorded by associate flora Ipomea pes-caprae, Sesuvium portulacastrum and Cynodon dactylon.

Abundance wise A. corniculatum was the most abundant with an abundance of 17.37 n/100 sq.m, followed by A. illicifolius with 16.8 n/100 sq.m, A. officinalis with 9.57 n/100 sq.m, L. racemosa with 5.43 n/100 sq.m, and R. apiculata with 5.16 n/100 sq.m. The lowest abundance was recorded in case of associate flora of I. pes-caprae (3.0n/100 sq.m), Derris trifoliata (2.0 n/100 sq.m), and S. portulacastrum (1.0n/100 sq.m).

Relative values of Density, Frequency and Dominance:

A. corniculatum recorded the highest Relative Density of 28.65%, followed by A. illicifolius, 17.32%, A. officinalis 13.81%, the least R.De. of 0.21% in case of S. portulacastrum. In terms of Relative Frequency, A. marina was the most frequent with a R. F. of 9.99%, followed by A. corniculatum with 8.88%, while A. alba, A. officinalis and L. racemosa had a R. F. of 7.77% each. In terms of Relative Dominance, A. marina had the highest R. D. of 42.153% followed by A. alba with 10.777%, the least R. D. of 0.471% was recorded in case of D. trifoliata.

Importance Value Index [IVI]

IVI was the highest in case of A. marina followed by A. corniculatum third highest IVI was recorded in case of A. officinalis. The least IVI was recorded in case of Bruguiera gymnorrhiza.

During the course of study, seedlings of R. mucronata, R. apiculata, K. candel, B. gymnorrhiza, B. cylindrica, and A. corniculatum, and A. officinalis were raised by Forest Department as per our suggestions and were transplanted at suitable spots with moderate success. However, because of continuous changes in the contours, depth and sandbars at the mouth of the creek resulted in mortality of standing vegetation and seedlings.

Faunal Studies:

The macrofauna of 34 species were recorded from the creek area. The animals that were found at Devbagh can be grouped into aquatic and terrestrial forms. The various aquatic animals that were found at Devbagh are:

Crustaceans: Thalassia anamala; Crabs - Metapagropsus messmar, M. annulata, Scylla serrata, S. tranucbarica, Matuta lunaris, Dotilla malabarica, Uca anulipa; Prawns Metapenaeous dossorii, M. affinis, Penaeus morganius, P, indicus, P. semisulcatus and among carideans Macrobrachium malcomsoni. Various other crustaceans like Alpheid shrimp, Isopods, Amphipods etc. Hermit crabs formed a prominent part of the benthic fauna present in the shells of Cerithidea and Telescopium.

The various molluscs that were observed are Gallonia bengalensis, Sanguinoloria diphos, Cerithidea sp., Telescopium sp., Hominoea tenera, Cassidula nuclius, Crossostrea sps etc. Only dead shells of Sanguinoloria diphos were found at the mouth of the creek being buried below the sand bar. The Brachipod Lingula antitha was observed to live in the silty patch that remained at the mouth of the creek.

The terrestrial fauna that were found at Devbagh are frogs during monsoon; Varanus, Calotes, Snakes, Buffaloes, Cows, Oxes, Rats, Fox etc.

DISCUSSION

The mangrove phytophetsy studied in Devbagh creek present a well established vegetation pattern as is clearly visible from the table depicting BDC. The presence of Avicennia marina in 6 of the 7 BDCs indicates the success with which this plant is capable to colonise and establish itself along the creek. The presence of A. alba and A. officinalis in 4 of the 7 BDCs also indicates the success ability of all the representatives of family Avicenniaceae to be able to colonise, establish and dominate in a tidal creek. The presence of Kandelia candel and Aegiceras corniculatum in only the first BDC can be an indication of its recent introduction and its existence in such a physical form throughout its life span respectively. The absence of Sonneratia alba from the first BDC is a bit alarming as it indicates that there are no propagules or the ones produced were unable to survive. The reason for this could be that all the plants that belonged to this species were either diseased or dead standing trees. The presence of all the other plants in the First BDC indicates their reproductive and propagational success at this creek.

The observation of high density of 1.39 n/100 sq.m in case of A. corniculatum and 0.84 n/10 sq.m in case of Acanthus illicifolius indicates that the plants that grow in the understorey of tall mangrove trees can play an important role in their contribution to the mangrove ecosystem by providing shelter to organisms that inhabit the mangroves and also contribute to the organic content of the estuary or tidal creek.
Table No 1. Density [Den], Basal Area Per Tree [BA/T], Frequency [Freq], Abundance [Abun], Relative values of Density [R.De], Frequency [R. Freq.] & Dominance [R. Do.], and Importance Value Index [IV] of Plants analysed from Devbagh Creek

<table>
<thead>
<tr>
<th>Genus species</th>
<th>Den. [n/10sq.m]</th>
<th>BA/T [Sq.m]</th>
<th>Freq. [%]</th>
<th>Abun. [n/100 sq.m]</th>
<th>R. De. [%]</th>
<th>R. Freq. [%]</th>
<th>R. Do. [%]</th>
<th>IV/VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhizophora apiculata</td>
<td>0.31</td>
<td>0.141</td>
<td>60.0</td>
<td>5.16</td>
<td>6.38</td>
<td>6.66</td>
<td>3.133</td>
<td>16.173</td>
</tr>
<tr>
<td>Rhizophora mucronata</td>
<td>0.13</td>
<td>0.244</td>
<td>40.0</td>
<td>3.25</td>
<td>2.68</td>
<td>4.44</td>
<td>2.274</td>
<td>9.394</td>
</tr>
<tr>
<td>Bruguiera cylindrica</td>
<td>0.14</td>
<td>0.436</td>
<td>60.0</td>
<td>2.33</td>
<td>2.88</td>
<td>6.66</td>
<td>4.381</td>
<td>13.921</td>
</tr>
<tr>
<td>Bruguiera gymnorrhiza</td>
<td>0.05</td>
<td>0.071</td>
<td>20.0</td>
<td>2.50</td>
<td>1.03</td>
<td>2.22</td>
<td>0.254</td>
<td>3.504</td>
</tr>
<tr>
<td>Kandelia candel</td>
<td>0.06</td>
<td>0.051</td>
<td>20.0</td>
<td>3.00</td>
<td>1.24</td>
<td>2.22</td>
<td>0.254</td>
<td>3.504</td>
</tr>
<tr>
<td>Avicennia marina</td>
<td>0.33</td>
<td>1.782</td>
<td>90.0</td>
<td>3.86</td>
<td>8.80</td>
<td>8.99</td>
<td>42.163</td>
<td>58.943</td>
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<td>Avicennia alba</td>
<td>0.09</td>
<td>1.670</td>
<td>70.0</td>
<td>1.29</td>
<td>1.86</td>
<td>7.77</td>
<td>10.777</td>
<td>20.407</td>
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<tr>
<td>Avicennia officinalis</td>
<td>0.67</td>
<td>0.224</td>
<td>70.0</td>
<td>9.57</td>
<td>13.81</td>
<td>7.77</td>
<td>1.767</td>
<td>32.347</td>
</tr>
<tr>
<td>Lumnitzera racemosa</td>
<td>0.38</td>
<td>0.309</td>
<td>70.0</td>
<td>5.43</td>
<td>7.84</td>
<td>7.77</td>
<td>1.767</td>
<td>32.347</td>
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<tr>
<td>Sonneratia alba</td>
<td>0.13</td>
<td>1.056</td>
<td>60.0</td>
<td>2.17</td>
<td>2.68</td>
<td>6.66</td>
<td>9.845</td>
<td>19.845</td>
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<td>Sonneratia caseolaris</td>
<td>0.07</td>
<td>0.298</td>
<td>40.0</td>
<td>1.75</td>
<td>1.44</td>
<td>4.44</td>
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<tr>
<td>Aegiceras corniculatum</td>
<td>1.39</td>
<td>0.029</td>
<td>80.0</td>
<td>17.37</td>
<td>28.65</td>
<td>8.88</td>
<td>2.945</td>
<td>40.475</td>
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<td>Exoceria agallocha</td>
<td>0.16</td>
<td>0.250</td>
<td>60.0</td>
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<td>3.30</td>
<td>6.66</td>
<td>2.867</td>
<td>12.827</td>
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<tr>
<td>Acanthus ilicifolius</td>
<td>0.84</td>
<td>---</td>
<td>50.0</td>
<td>16.8</td>
<td>17.32</td>
<td>5.56</td>
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<td>---</td>
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<tr>
<td>Derris trifoliata</td>
<td>0.04</td>
<td>0.164</td>
<td>20.0</td>
<td>2.0</td>
<td>0.82</td>
<td>2.22</td>
<td>0.471</td>
<td>3.511</td>
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<tr>
<td>Ipomea pes-capra</td>
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<td>---</td>
<td>10.0</td>
<td>3.0</td>
<td>0.62</td>
<td>1.11</td>
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<tr>
<td>Sesuvium portulacanum</td>
<td>0.01</td>
<td>---</td>
<td>10.0</td>
<td>1.0</td>
<td>0.21</td>
<td>1.11</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Clerodendron inerme</td>
<td>---</td>
<td>---</td>
<td>60.0</td>
<td>---</td>
<td>---</td>
<td>6.66</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Cynodon dactylon</td>
<td>0.02</td>
<td>---</td>
<td>10.0</td>
<td>---</td>
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<td>---</td>
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</tr>
</tbody>
</table>

Table No 2 Percentage of plants at Devbagh creek of different Basal Diameter Class [in cms]

<table>
<thead>
<tr>
<th>Genus species</th>
<th>0.1-5.9</th>
<th>6.0-10.9</th>
<th>11.0-15.9</th>
<th>16.0-20.9</th>
<th>21.0-25.9</th>
<th>26.0-30.9</th>
<th>&gt;31.0</th>
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<tbody>
<tr>
<td>Rhizophora apiculata</td>
<td>90.32</td>
<td>6.45</td>
<td>3.23</td>
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<td>---</td>
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<tr>
<td>Rhizophora mucronata</td>
<td>69.23</td>
<td>23.07</td>
<td>7.68</td>
<td>---</td>
<td>---</td>
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<tr>
<td>Bruguiera cylindrica</td>
<td>35.71</td>
<td>50.00</td>
<td>14.28</td>
<td>---</td>
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</tr>
<tr>
<td>Bruguiera gymnorrhiza</td>
<td>80.00</td>
<td>20.00</td>
<td>---</td>
<td>---</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Kandelia candel</td>
<td>100.00</td>
<td>---</td>
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<td>---</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Avicennia alba</td>
<td>11.11</td>
<td>22.22</td>
<td>33.33</td>
<td>11.11</td>
<td>22.22</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Avicennia officinalis</td>
<td>88.06</td>
<td>4.35</td>
<td>1.45</td>
<td>4.35</td>
<td>1.46</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Lumnitzera racemosa</td>
<td>63.16</td>
<td>23.68</td>
<td>10.52</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sonneratia alba</td>
<td>---</td>
<td>46.15</td>
<td>53.85</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sonneratia caseolaris</td>
<td>42.86</td>
<td>42.86</td>
<td>14.29</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Aegiceras corniculatum</td>
<td>100.00</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Exoceria agallocha</td>
<td>62.50</td>
<td>37.50</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

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Avicennia marina occurred most frequently in this case study with Frequency of 90%. Its occurrence in 6 BDCs with maximum Basal Area Per Tree and a Relative Dominance of 42.153%, shows the importance and success this plant has achieved in surviving under the varied environmental conditions that exist in this tidal creek.

Aegiceras corniculatum was the next most important species in the present case with an IVI of 40.476 second only to A. marina that showed an IVI of 58.943%. A look at the values of the IVI of each species reveals maximum of 58.943% in case of A. marina and a lowest of 3.511 in case of Durieis trifoliata. With all other species with an Intermediate IVI. This gives us a picture of an ecosystem in which the scene is dominated by A. marina, followed by A. corniculatum, L. racemosa, R. apiculate etc. The plants belonging to the family Avicenniaceae were most dominant followed by Rhizophoraceae indicating the manner in which a particular family of plant colonises an estuary or tidal creek. This shows the heterogeneity that exists in a mangrove ecosystem and how the plants of different species contribute to the well being of the ecosystem.

A very interesting observation made during the present investigation is that, some of the plants that grow in low salinity such as B. cylindrica, B. gymnorrhiza E. agallocha, S. alba, A. ilicifolia and A. officinalis share the habitat with plants growing in high salinity zone like A. marina, and R. mucronata. The contours, depth, vegetation and the sand bars at the mouth of the creek keep changing. This could be due to the breakwater built to protect Karwar harbor having something to do with changing direction of the current and intensity of the waves and tides leading to its impact on the creek mouth. The pillars of National Highway Bridge built across river Kali also may have some role in the change of direction of downflow of water.

CONCLUSION AND SUGGESTIONS
Devbagh creek being a new found mangrove habitat, this is the first research work carried out. In this work, Bruguiera cylindrica, an eumangrove, along with Sesuvium portulacacieum and A. marina are reported for the first time from Karwar region. A medicinal plant, Rauwolfia tetraphylla is abundant in the surrounding Casuarina plantation.

Devbagh creek, being away from human settlement and fenced by the Forest Department for their mangrove nursery and Casuarina plantation, is not under much of anthropogenic activity. In view of tourism potential this place could be considered for declaration as a Bio-reserve or Marine park as it has very significant growth of mangroves with water ways and a high degree of biodiversity next only to the Sunderbans. A few plants that are not found here in other parts of Kali estuary could be introduced here to make this place biologically richer. The place appears to be ideal to setup a germ plasm bank of mangroves for the West Coast.

This creek is lying close to the Devbagh resort run by Jungle Lodges, a tourism development wing of Forest Department. Being an attractive tourist spot it is prone to pollution. Also, evacuues from the project 'sea bird' are provided settlement space nearby and therefore there is likely destruction of this mangrove for firewood. It could be ideally developed, by fencing all around, a little dredging of water ways and the main lake, building a trekking path all around, a stone wall with gate for tidal flow at the mouth of the creek. This will be a good Eco-tourism spot with boating, hiking and camping facilities for the tourists, students of schools and colleges visiting for education and entertainment purpose. The scenic beauty of this area is unique as it overlooks Kali river mouth, Kodilag sand bar, estuary, bridge, hills around, sea-islands, Karwar beach and harbor.

REFERENCES