

## Distribution of mangroves in relation to topography and selection of ecotonal communities for reclaimed areas of Sunderbans

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Marked differences were recorded in structure and composition of mangroves from the islands in the eastern and western sectors of Sunderbans in relation to the topography. *Avicennia* sp. and *Aegiceras* sp. preferred low lying areas towards the western and eastern sides of Sunderbans respectively. *Ceriops-Phoenix* association was frequent in high land areas and *Excoecaria* and *Ceriops decandra* occurred over the entire forest with different salinity and topography. Association patterns of different mangroves were shown in profile diagrams and ideal ecotonal mangrove communities were suggested for reclaimed regions.

Forest area<sup>1</sup> of mangroves of Sunderbans, India is about 4200 km<sup>2</sup> and is a potentially productive ecosystem. The productivity of this ecosystem has declined<sup>2</sup> due to various human activities and increase in sediment load<sup>3</sup> and salinity in the aquatic environment. To keep this entire system productive a better management practice needs to be worked out. One of the methods could be the introduction of ecotonal communities in the reclaimed islands. Selection of ecotonal communities for an area cannot be random as salinity in east and west of Sunderbans is different, and the topography changes in a close proximity<sup>4</sup> and the pattern of plant community in the forests is controlled more by the topography<sup>5</sup>. Therefore, different plant communities growing in different topographical conditions in the reserved forest have been studied for selection of appropriate ecotonal communities for the reclaimed islands.

### Materials and Methods

Islands like Prentice (1), Thakuran (2), Natidhopani (3), Arbesi (4), Jhilla (5), Harinbhangha (6) and Khatoajhori (7), distributed in Sunderbans (Fig. 1), were investigated. Site selection was made considering the nature of submergence of the forest floor. The topography in relation to tidal submergence was measured during high tide. An elevated area above the low tide level was measured by noting the height of landmass in relation to water table at high tide. Depth of submergence of different positions of a transect was thus measured and the values were plotted in profile diagrams to denote the topography, taking the low tide level as 0 altitude. Average

values of high tide level (HT) and highest high tide (HHT) level were derived from the chart datum of Calcutta port and were plotted in the diagram.

Vegetation was analysed from 6 quadrats (10×10m) on a line transect of 60m length stretched on the landmass at right angle to the shore

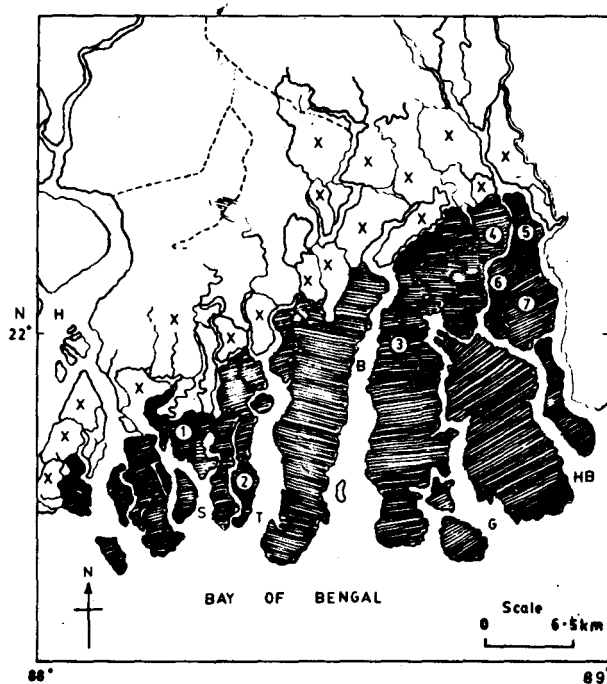


Fig. 1—Sunderbans showing reserved forests [hatched], reclaimed areas [cross-hatched] and islands [islands: 1-Prentice; 2-Thakuran; 3-Natidhopani; 4-Arbesi; 5-Jhilla; 6-Harinbhangha and 7-Khatoajhori. Important rivers: H - Hooghly, S - Saptamukhi, T - Thakuran, B - Bidya, G - Gosaba, HB - Harinbhangha]

line. Frequency of plant species was determined following the technique of Kellman<sup>6</sup>. A community was named according to the density values of first 3 dominant species<sup>7</sup>. Number of representatives of a particular species was presented in each diagram in proportion to the density value of that species and arranged in accordance with the nature of dispersion as indicated by their frequency in various topographic contours.

**Results and Discussion**

Distribution pattern of mangroves at different islands in Sunderbans is presented in Fig. 2, and frequency and density of mangroves are given in Table 1. Density of plants are different in different islands. The community types identified in islands are never

alike as the first 3 dominant plants in an island are unique for that island only. *Ceriops* or *Excoecaria*, however, are widely dispersed taxa and either of them appear as one of the first 3 dominant plants in most of the islands studied (Table 2). Majority of the forest vegetation at Sunderbans is distributed on slopes and ridges. The mudflat is occasionally barren (Fig. 2A). Landform undulations are of various types and so, the intensity of tidal actions differs from place to place depending on the height of landmass. Ridges may be high lands (4m above low tide level, Fig. 2B), or even low lands (1.6m above low tide level, Fig. 2F). Similarly, the slopes may be at a narrow or wider angles. The distribution pattern of plant communities and the structure of the forest are largely determined by topography. Islands like Tha-

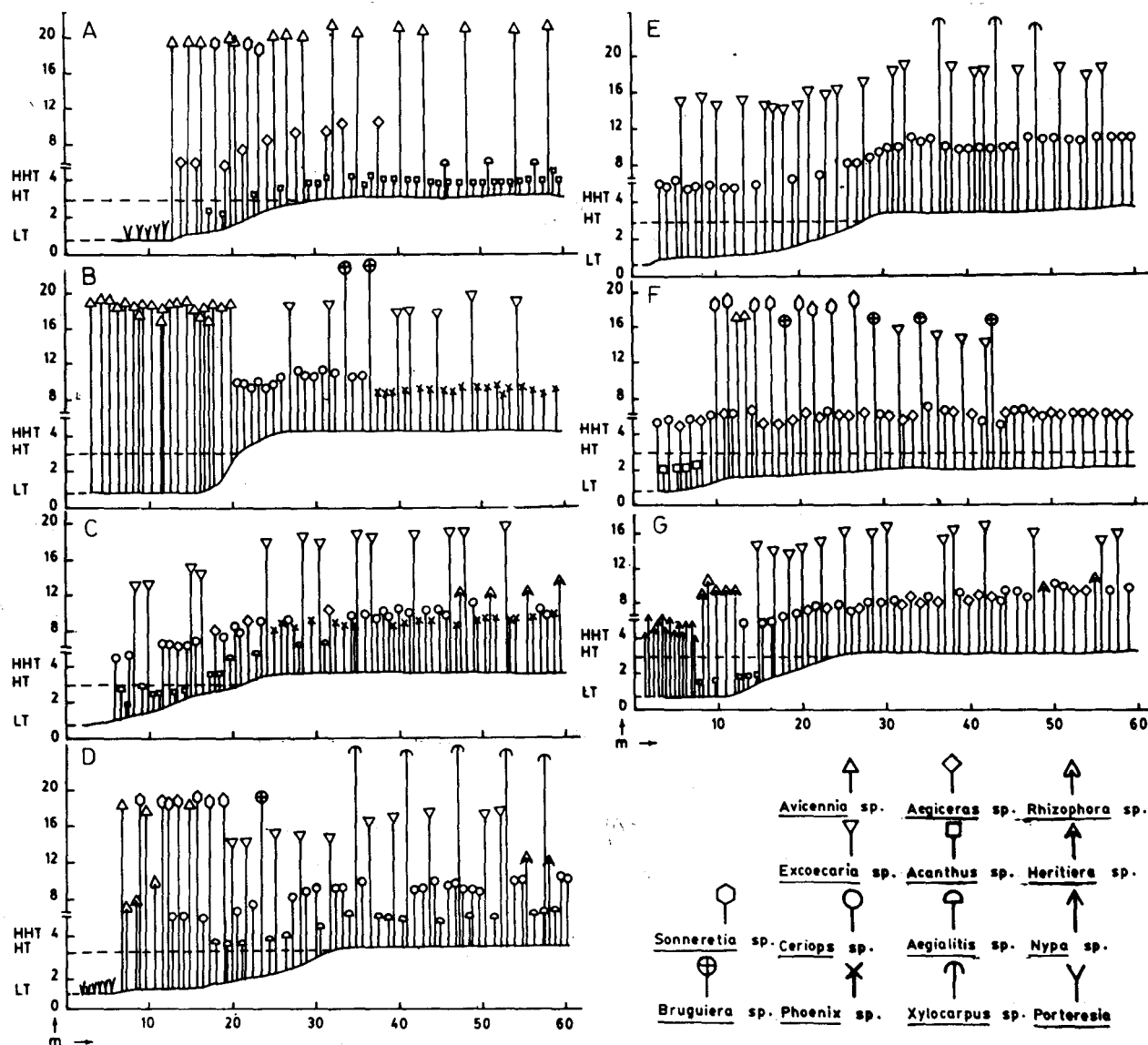


Fig. 2—Profiles showing distribution of mangroves at (A) Prentice, (B) Thakuran, (C) Natidhopani, (D) Arbesi, (E) Jhilla, (F) Harinbhanga, and (G) Khatoajhori [LT = mean low tide, HT = mean high tide, HHT = mean highest high tide]

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Table 1—Frequency (F,%) and density (D, no. ha<sup>-1</sup>) of mangroves

Species	West		Central				East							
	Prentice		Thakuran		Natidhopani		Arbesi		Jhilla		Harinbhanga		Khatoajhori	
	F	D	F	D	F	D	F	D	F	D	F	D	F	D
<i>Avicennia alba</i> Bl.	83.3	2717	33.3	1783			33.3	83			16.7	33		
<i>A. officinalis</i> L.	83.3	783	33.3	316			33.3	50						
<i>Rhizophora conjugata</i> L.													33.3	383
<i>R. mucronata</i> Lamk							33.3	33						
<i>Bruguiera gymnorrhiza</i> (L) Lamk			16.7	50			16.7	17			66.7	133		
<i>Ceriops decandra</i> (Griff) D. Hou			33.3	350	100	2800	83.3	4450	100	1700	100	3900	83.3	6100
<i>C. tagal</i> (Perr.) C.B. Rob.			33.3	117	100	800								
<i>Sonneratia apetala</i> Buch.Ham	33.3	83					33.3	66			33.3	183		
<i>Xylocarpus moluccensis</i> (Lamk) Roem.								66	33.3	33				
<i>X. granatum</i> Keenig.										33.3	33			
<i>Aegialitis rotundifolia</i> Roxb.	50	83			66.7	133	83.3	1867						
<i>Aegiceras corniculatum</i> (L) Blanco	50	333			50	66					100	16400	66.7	633
<i>Heritiera fomes</i> Buch.Ham					33.3	100	16.7	33					33.3	67
<i>Acanthus ilicifolius</i> L.	83.3	2350			33.3	200					16.7	150	33.3	200
<i>Excoecaria agallocha</i> L.			66.7	233	100	100	83.3	1783	100	1300	33.3	83	83.3	1400
<i>Nypa fruticans</i> Wurm.													16.7	700
<i>Phoenix paludosa</i> Roxb.			50	1050	66.7	2600								
<i>Porteresia coarctata</i> (Roxb.)	16.7	23783					16.7	24600						

Table 2—First three dominant plants (community) in different islands

Islands	Community
Prentice	<i>Acanthus - Avicennia - Aegiceras</i>
Thakuran	<i>Avicennia - Phoenix - Ceriops</i>
Natidhopani	<i>Ceriops - Phoenix - Excoecaria</i>
Arbesi	<i>Ceriops - Aegialitis - Excoecaria</i>
Jhilla	<i>Ceriops - Excoecaria - Xylocarpus</i>
Harinbhanga	<i>Aegiceras - Ceriops - Sonneratia</i>
Khatojehori	<i>Ceriops - Excoecaria - Nypa</i>

kuran or Natidhopani have different levels of salinity [conductivity: 5.7m. mhos cm<sup>-1</sup>, and 6.4m. mhos cm<sup>-1</sup> respectively] but both include elevated ridges and the slopes at steeper angles. *Phoenix-Ceriops* association dominates the forests in both the islands (Fig. 2B and C). Conversely *Phoenix* is not observed in any other island showing low land areas. *Avicennia* is a major associate of *Phoenix-Ceriops* association of Thakuran. But, in Natidhopani *Excoecaria* is the main associate. *Excoecaria* therefore, can grow in highly saline soil of elevated ridges at Natidhopani. Salinity in high lands is usually augmented due to its more exposure to evaporation. *Excoecaria* also

grows equally well in less saline soil<sup>7</sup> (conductivity: 3.44 m. mhos cm<sup>-1</sup>) of Jhilla (Fig. 2E). Results indicate that both salinity and the topography are important controlling factors for the distribution of plant types in Sunderbans.

The species diversity in eastern Sunderbans (Fig. 2C, D and G) is more than that in western (Fig. 2A, B). *Aegiceras corniculatum*, *Sonneratia apetala*, *Excoecaria agallocha*, *Rhizophora mucronata*, *Nypa fruticans* are more dense in eastern islands while *Avicennia alba*, *A. officinalis*, *Acanthus ilicifolius* are denser in western islands. Mangroves of Sunderbans in general prefer low land ridges or slopes which remain submerged for a longer period. A few taxa like *Xylocarpus moluccensis* and *Heritiera fomes* however are observed in moderately elevated ridges of central and eastern Sunderbans. *Bruguiera gymnorrhiza* prefer slopes and usually occur in groups as an edge community. Species of *Ceriops decandra*, *Aegialitis rotundifolia* and *Acanthus ilicifolius* are the undergrowths in this forest and sometimes grow with high density (Table 1); *Ceriops decandra* is rare on the mudflat, *Acanthus ilicifolius* often grow with *Poeteresia coarctata* in the mudflat (Fig. 2A).

Distribution of mangrove in east and west of Sunderbans is different mainly due to difference in salinity (conductivity: 3.44-4.61 m mhos  $\text{cm}^{-1}$  in east, and 5.3-5.7 m mhos  $\text{cm}^{-1}$  in west)<sup>7</sup>. Salinity in soil of different topography is also different as the tidal actions and the exposure of the landmass to evaporation vary. Sometimes with the diffusion of topographical demarcations in a place vegetation appears mosaic in nature (e.g. Natidhopani). Occurrence of mosaic mangroves has been reported from SE Mozambique<sup>8</sup>.

Therefore, for the afforestation in the riparian side of the reclaimed islands suitable ecotonal communities can be selected. *Avicennia officinalis* alone, or with *Sonneratia apetala* can be regenerated in the slopes or low land areas which are less than 3m altitude above low tide level; or *Aegiceras-Acanthus* association in moderately elevated slope in west Sunderbans. A pure stand of *Aegiceras* may suit a low land in east Sunderbans; *Xylocarpus* and *Ceriops* together may be planted in moderately elevated landmass in the east. For the low land reclaimed islands in the east which receive high wave action *Rhizophora mucronata* will be most suitable. *Nypa* and

*Rhizophora* can be grown together in low land area in east with less wave actions. *Acanthus* may be recommended as a mudflat community specially for west, and can be planted alone or in association with *Porteresia*. *Excoecaria* and *Ceriops* are suitable for plantation in all different types of slopes and ridges over the forest.

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