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Studies on Soil & Vegetation of Mangrove Forests of Sunderbans

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Soil and vegetation of mangrove forests in some islands of eastern and western side of the Sunderbans were surveyed. Physico-chemical characters of soils in both sides were basically similar except in conductivity, soil texture and NPK ratio. Distribution of mangrove species in the two sides was however different. Western islands were dominated by *Avicennia* sp. and *Acanthus ilicifolius* while the eastern side was dominated by *Aegiceras majus* although density of *Ceriops* sp. and *Excoecaria agallocha* was considerably high.

Sunderbans comprise discrete islands in the southern part of Bengal basin on the Bay of Bengal (Fig. 1). Distribution of mangrove forests in the east and west of sunderbans is not similar[1,2] though the origin of soil in this part of the basin is same[3]. In the present investigation, soil and vegetation of the mangroves in the eastern and western parts are studied to understand the differences in the distribution of mangroves.

Geologically this part of the delta is dynamic and the rate of delta formation is rapid[4] resulting in discontinuity in land mass. The tidal influence is diurnal and annual mean tide level is 2.5 m.

Materials and Methods

Survey of vegetation and soil was conducted simultaneously in different islands (Fig. 1) named as Prentice (P) and Thakuran (T) in the west; Natidhopani (N) and Chitori (C) in the central; and Harinbhanga(H), Khatoajhori(K) and Jhilla(J) in the east. Soil sampling was made from the same site where vegetation was studied.

*p*H was measured in a *p*H meter (model PM2, Optronics) using soil water ratio 1:2.5, electrical conductivity was measured by conductivity bridge taking soil water ratio 1:5, and CEC with neutral normal ammonium acetate[5]. Physical properties of soil like water holding capacity, pore space, apparent density were determined[6]. Mechanical analysis for texture was carried out using the international pipette method[6]. Available nitrogen was determined by alkaline permangnate method[7]. Available phosphorus was estimated with molybdate reagents[4]. Estimation of calcium and magnesium was done by E.D.T.A. following the method of Jackson[4]; sodium and potassium contents were estimated by flame photometer[8]. Carbonates and bicarbonates were

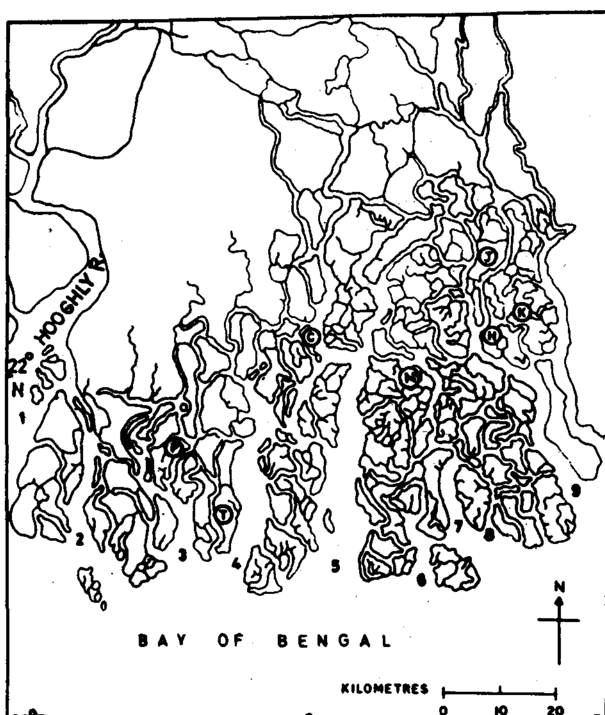

Fig.1—Sunderban area showing islands investigated [H-Harinbhanga, K-Khatoajhori, J-Jhilla, N-Natidhopani, C-Chitori, T-Thakuran and P-Prentice. Rivers: 1-Hooghly, 2-Muriganga, 3-Saptamukhi, 4-Thakuran, 5-Matla, 6-Chamta, 7-Gosaba, 8-Gona, 9-Harinbhanga

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determined by titrating the solution with HCl using phenopthalin as indicator; and chloride was measured by titration with $AgNO_3$ using potassium chromate[9]. pH and conductivity of water were measured following the similar procedure stated above. Quantitative data of vegetation from each site were collected by counting different species of plants occurring in 6 quadrates (10m × 10m) distributed in a line transect plotted perpendicular to the edge of the canals. Density of different species was determined by counting the total number of individual and it was expressed as a fraction of the area of quadrates in square metre studied, and expressed as individuals per hectare[10]. Communities were named according to the first 3 dominant species as indicated by their density data.

Results and Discussions

Physico-chemical characters (Table 1) of soil occurring in different islands of sunderbans are not much different. Clay content is more (33.2 - 39.5%) in the soil of eastern part with high water holding capacity while soil in the western part are more sandy (6.3 - 7.3%) and porus. Increased sand content in the western islands may be due to gradual detour and consequent increase in rate of sedimentation in the river beds[4]. Also, conductivity was more (5.7 m mhos.cm $^{-1}$) in soil of western islands than that (4.15 m mhos.cm $^{-1}$) in the islands of the east. Increase of salinity in western islands may be due to decline in the fresh water discharge in the west in association with the tilting of the basin towards east[4]. The values of both

Table 1—Physico-chemical Characteristics of Soil from Different Islands (values are mean of 3 readings)

	East			Central		West	
	H	K	J	N	C	T	P
Sand (%)	2.1	1.09	1.06	4.03	5.50	6.29	7.29
Silt (%)	62.1	64.5	53.5	78.87	78.35	76.71	75.90
Clay (%)	35.0	33.2	39.5	17.10	16.28	16.61	16.17
Texture	Silty clay loam	Silty clay loam	Silty clay loam	Silty	Silty	Silty clay	Silty
Maximum water holding capacity(%)	65.5	71.5	63.5	75.23	67.69	72.95	67.89
Pore space(%)	37.84	40.32	41.28	38.24	46.93	39.02	45.32
Apparent density (g.cc $^{-1}$)	0.34	0.38	0.34	0.52	0.47	0.40	0.48
pH	8	8.2	7.9	8.2	8.1	8	8.4
Conductivity (m mhos.cm $^{-1}$)	4.61	4.40	3.44	6.4	5.3	5.7	5.6
CEC(m eq.100g $^{-1}$)	21.77	27.72	19.98	28.99	34.03	18.36	26.52
Exchangeable cations (m eq.100g $^{-1}$)							
Ca^{2+}	15.68	22.02	15.32	22.56	27.91	12.81	20.70
Mg^{2+}	1.18	1.12	0.98	1.01	0.95	1.01	1.02
Na^+	2.38	2.23	1.96	3.20	2.30	1.98	2.30
Available nutrient (ppm)							
Nitrogen	148.6	140	154	96.2	95.5	55.9	96.3
Phosphorus	20.8	21	17	16	20	19	18
Potassium	709.87	585	636.82	772.2	676.4	1844.2	542.1
Composition in saturation extract (m eq.l $^{-1}$)							
Na^+	11.72	9.95	12.20	17.13	13.57	12.21	11.13
$Ca^{2+}+Mg^{2+}$	2.61	1.50	2.92	2.1	1.7	1.95	1.7
K^+	0.44	0.22	0.52	0.26	0.28	0.42	0.36
$CO_3^=$	0.02	0.02	0.01	0.02	0.01	0.01	0.02
HCO_3^-	1.37	1.30	0.92	0.89	1.10	0.71	0.89
Cl^-	9.33	6.50	9.32	13	9.8	11.5	11.2

apparent density and absolute specific gravity were appreciably low in all soils which is a very specialized character of sunderban soil. Further, the clay fraction is smectit, in general and it swells abnormally. Presence of high concentration of dissolved inorganic salts is also a feature of sunderban soil and so the electrical conductivity of such soil solutions is high. Soil sampled from different topographic zones like mud flat, slope and ridge showed differences. Soil occurring in elevated regions (like ridge) was more saline. It was due to more exposure for the surface evaporation. Soil *p*H was alkaline (7.8 - 8.4) though alkalinity was more towards the eastern side. Also, the nitrogen content of soil of eastern islands was high (140 - 154 ppm). But, no difference was observed in phosphorus content; rather the concentration of phosphorus varied considerably from one island to other and the cause for such variability cannot be given. Potassium content again differed in soil of eastern and western islands. As a result, NPK ratio was different. The occurrence of considerably high value of carbon in islands H (0.92%) and in T (0.76%) was interesting. It may be due to accumulation of unwashed litter in the soil and the phenomenon seems to be a local factor. C:N ratio of the soil of eastern and western islands was also different and it may mainly be due to differences in nitrogen content.

Density values of vegetation (Table 2) indicate that distribution pattern of some important plants species changes gradually from west to east of the forest. Now, the question is whether the areawise dominance and the amplitude of species can be correlated with soil characters. From Tables 1 and 2 it appears that *Avicennia alba* and *Acanthus ilicifolius* are dominant in the islands where the salinity, CEC, Cl^-, water holding capacity of soil, sand and silt content were high. That *A. alba* grows in high salt concentration has been shown recently[11]. On the contrary, *Aegiceras majus* and *Excoecaria agallocha* are dominant in the islands where salinity, CEC, sand and silt content are comparatively low with high nitrogen and clay content. Species like *Ceriops roxburghiana* and *Excoecaria agallocha* occur in abundance throughout the area showing a wide range adaptibility. Some other taxa were also observed to be ecologically important though their density was low. For example, *Heritiera fomes* and *Nypa fruticans* grow only in the east and not in the west. Similarly, only a very few plants of *Avicennia* sp. were found in the eastern islands. Other species like *Rhizophora mucronata* and *Xylocarpus mollucensis* are frequent in islands like N and C which are neither in the east nore in the west. However, the salinity of these islands, in the centre, was similar to that of the western islands. Nitrogen content and CEC values of 2 islands however differ from those of the east and west. *Phoenix paludosa* is an interesting species because it grows in a typically high land without any direct tidal actions and where salinity is high. Also, they are frequent in the western islands. It can be concluded therefore that existing differences in salinity, *p*H, CEC, etc. in the eastern and western islands along with some other differences in soil texture and NPK ratio mainly, seem to be responsible for the control of the distribution of at least some mangrove species in sunderban forests though not all. Conversely, there are some species which are indifferent to these differences in soil characters and so they grow all over the forests.

Table 2—Mangrove Species Density of Dominant Community in Different Islands

Island	Dominant species	Density (No. hectare^{-1})
H	*Aegiceras majus* Gaertn.	16400
	Ceriops roxburghiana Arn.	3900
	Sonneratia apetala Ham.	0.02
K	*Ceriops roxburghiana* Arn.	6100
	Aegiceras majus Gaertn.	1800
	Excoecaria agallocha L.	1400
J	*Excoecaria agallocha* L.	1300
	Ceriops roxburghiana Arn.	1700
	Xylocarpus mollucensis (Lamk) Roem	0.002
N	*Ceriops roxburghiana* Arn.	3600
	Phoenix paludosa Roxb.	2600
	Excoecaria agallocha L.	1100
C	*Ceriops roxburghiana* Arn.	3000
	Excoecaria agallocha L.	1600
	Bruguiera gymnorrhiza (L) Lamk.	1100
T	*Avicennia alba* Bl.	2100
	Phoenix paludosa Roxb.	0.08
	Ceriops roxburghiana Arn.	0.03
P	*Acanthus ilicifolius* L.	23500
	Avicennia alba Bl.	3500
	Aegiceras majus Gaertn.	0.03

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