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SOIL AS A FACTOR INFLUENCING THE MANGROVE FOREST COMMUNITIES IN TALIDENDANG BESAR, RIAU

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ABSTRACT

One transect of 10 m x 900 m was constructed perpendicular to the sea edge to know the pattern of mangrove forest communities from the sea edge through the inland area. Then, one sample plot of 50 m x 50 m was established at each forest community to explore its vegetation structure and soil characteristics.

The results show that in Talidendang Besar area, there are three mangrove forest communities stretching from the sea edge to the inland, namely *Bruguiera parviflora, B. sexangula* and *B. sexangula-Nypa fruticans*. The soil factors such as pH.EC (electrical conductivity), % K, % Na, C-organic, N-total, NH_4 (ammonia), and CEC (cation exchange capacity) were regarded important in influencing the pattern of the mangrove forest communities.

INTRODUCTION

Darsidi (1987) reported that the mangrove forest in Indonesia covers an area of approximately 4.25 million ha, of which about 276 000 ha are distributed in Riau. Most of the mangrove forests in Riau are located at the east coast where the major tidal swamp land areas are under development for transmigration projects.

Numerous environmental factors operate in mangrove swamps, but the most important are soil type, salinity, drainage, and water currents (Chapman 1975). Steenis (1958) stated that the soil type is more important than the other factors in controlling the zonation of mangroves. In any area with fairly uniform climate, the chemical differences in the soil may produce marked changes in the vegetation (Billing 1950).

While the mangrove forest in Indonesia is believed to be the largest in the world (Christensen 1982), studies on the physico-chemical properties of mangrove soils are still few (Soegiarto 1979).

The present study was done to investigate the soil factors influencing the mangrove forest communities in Talidendang Besar, Riau. It is hoped that the results of this research may contribute to the establishment of proper mangrove forest management in Indonesia.

MATERIALS AND METHODS

This research was conducted in a mangrove forest concession area at Tali-dendang Besar belonging to the PT Bina Lestari which is located in the Kateman District, Indragiri Hilir Regency, Riau Province. Geographically, this mangrove forest area is located at the east coast of Sumatera with gentle topography and altitude of 0- 3 m above sea level between Long. 103° 28' to 103° 48' E and Lat. 0° 21' to 1° N (Figure 1). Based on the systems of Schmidt and Ferguson (1951), the Tem-

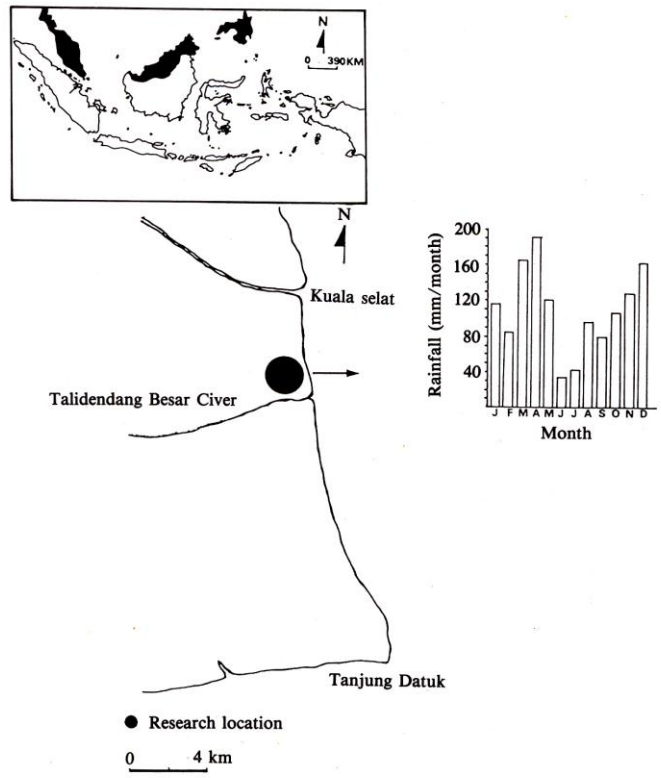

Figure 1. Location and the climatic diagram ofthe mangrove forest area of Talidendang Besar, Riau.

bilahan research area has a B climate type with seven wet months, two dry months, and three humid months (Badan Meteorologi dan Geofisika 1990). The soils of this area are organosol and glei humus (Lembaga Penelitian Tanah 1964).

To investigate the forest community from the sea edge to the inland, one transect of 10 m x 900 m was divided into 10 m x 20 m contiguous subplots and constructed perpendicular to the sea edge. Within these subplots, the DBH (diameter at breast-height) of all trees (plants with DBH 10 cm up) was measured. Then, one sample plot of 50 m x 50 m was established in each forest community type to explore its vegetation structure and soil characteristics. Four soil samples up to a depth of 25 cm were collected randomly from the area within each adjacent sample plot of 50 m x 50 m. Each soil sample was analysed for texture, pH, C-organic, EC (electrical conductivity), CEC (cation exchange capacity), N-total, NH4 (ammonia), and exchangeable cations (K, Na, Mg, Ca) at the soil laboratory of the Faculty of Agriculture, Bogor Agricultural University.

The vegetation data were analysed using Cox's method (1967) and the importance value index (Curtis and Mclntosh 1951) was used to determine the vegetational importance of a species within the forest community.

RESULTS AND DISCUSSION

A. Vegetation Composition

As shown in Figure 2, the mangrove forest from the sea edge to the inland in Talidendang Besar could be divided into three different forest communities, namely, *Bruguiera parviflora* community which occupied the area from the sea edge to about 180 m inland, *B. sexangula* community from about 180 m to 740 m inland, and *B. sexangula-N. fruticans* community from about 740 m to 900 m inland as transition area with swamp forest.

Table 1 shows that in the *B. parviflora* community, *B. parviflora* was considered the dominant species and *B. sexangula* the codominant one. In the *B. sexangula* community, *B. sexangula* was considered the dominant species and *B. parviflora* the codominant one, while in the *B. sexangula-N. fruticans* community, *B. sexangula* was dominant and TV. *fruticans* codominant.

There is a marked tendency for the density and basal area of *B. parviflora* to decrease from the sea edge *(B. parviflora* community) to the inland *(B. sexangula-N. fruticans* community). The opposite occurred for the density and basal area of *B. sexangula* which tended to increase toward the inland area. In addition, the further from the sea edge, the more varied was the tree species richness. It is assumed that the less severe site conditions in the inland area give the chance to

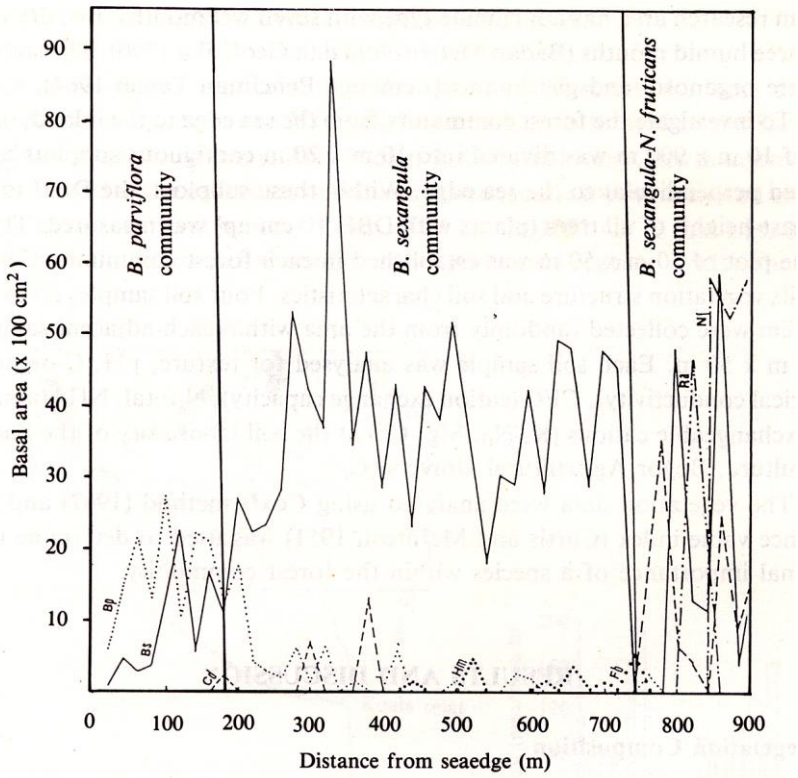

Figure 2. Mangrove forest community from sea edge through inland in mangrove forest area of Talidendang Besar, Riau. Bp *(B. parviflora)*, Bs *(B. sexangula)*, Cd (C. *decandra)*, Hm (*//. microcarpum)*, Fb *(F. benjamina)*, Ra *(R. apiculata)*, and Nf (TV. *fruticans).*

Table 1. Species density and species importance value index (IVI) of trees at three forest communities in a mangrove forest of Talidendang Besar, Riau

Community type	Species	Density (in./ha)	IVI
1. *B. parviflora* community	*B. parviflora*	392	171.95
	B. sexangula	200	128.05
2. *B. sexangula* community	*B. parviflora*	164	100.12
	B. sexangula	300	199.89
3. *B. sexangula N. fruticans* community	*B. parviflora*	8	8.33
	B. sexangula	340	199.93
	R. apiculata	16	22.26
	F. benjamina	4	4.17
	N. fruticana	56	65.31

many species for a better growth. Johnstone (1983) stated that the presence of terrestrial species in the back zone of mangal is more indicative of the salinity regime than representing an active process of colonization from the land as part of an integrated successional system.

B. Forest Community Occurrence as Related to Soil Factors

As shown in Table 2, the soils which occupied each forest community have a high percentage of clay, an intermediate percentage of silt, and a low percentage of sand. This indicates that the mangrove forest area in Talidendang Besar receives much eroded soil containing fine soil particles through the stream flow from the upper river basin of Talidendang Besar. It is probably due to the extensive conversion of peat swamp forest to coconut plantation mainly by the Bugis people who came from the southern part of Sulawesi. The soils covered either by *B. parviflora* or *B. sexangula* communities were classified as clay, while the soils covered by *B. sexangula-N. fruticans* were classified as silty clay. The soils of this mangrove forest area were almost the same as those of the mangrove forest area in Ujung Karawang, Cilacap (Al Rasyid 1971; Soerianegara 1971), and Bengkalis (Dinas Kehutanan Propinsi Dati I Riau 1978).

The pH of the soils which covered each of the forest community was generally neutral due to the decreasing percentage of exchangeable cation content in the soils from the sea edge of the inland area. Similarly the salinity (electrical conductivity) of the soils tends to decrease toward the inland, but generally the salinity of the soils occupied by each forest community was considered low, and the adsorption site of the soils was dominated by cations in the order of Ca > Mg > Na > K. This is suggested to be due to the fact that the mangrove forest in this area receives much fresh water through the stream flow of Talidendang Besar river, while the area toward inland was infrequently submerged by sea water.

C-organic, NH_4 (ammonia), N-total, and CEC (cation exchange capacity) increased toward inland. It indicates that toward the inland area the organic matter and its decomposition process tends to increase. It is probably correlated with the maturity of the trees and the soil substrate condition in these forest communities. Based on the average height and diameter of the trees in these forest communities (Table 1), the inland area of the forest community appears to be occupied by more mature trees as suggested by the amount of litter fall on the forest floor. In addition, the dense aerial roots and the *Acrostichum aureum* on the floor of the *B. sexangula* and *B. sexangula-N. fruticans* communities play an important role in trapping leaves and debris during tidal inundation, thereby contributing to the high organic matter content in these forest communities. The increasing content of N and NH_4 of the soil covered by the forest community toward inland indicated a more rapid decom-

Table 2. Values of soil characteristics (mean ±95% confidence limit) occupied by each mangrove forest community in Talidendang Besar, Riau.

No.	Forest community	Soil characteristics													
		pH* (H_2O)	C-org.** (%)	N-total* (%)	%Ca**	%Mg**	%K*	%Na**	CEC** (me/100 g)	NH_4* (ppm)	EC* (mmS/cm)	Sand (%)	Silt (%)	Clay (%)	Texture class
1.	*Bruguiera parviflora* community	7.5±0.18	4.17±0.64	0.21±0.03	78.15±16.77	66.62=23.56	8.08±0.22	32.93±0.18	39.33±1.19	36.54±14.38	2.06±0.11	0.15±0.09	37.75±6.09	62.10±6.16	clay
2.	*Bruguiera sexangula* community	7.4±0.19	10.68±3.32	0.36±0.05	74.98±5.35	65.32=8.92	6.36±0.48	23.97±1.99	59.13±9.94	74.78±17.58	1.80±0.22	0.07±0.05	33.84±5.36	63.98±6.25	clay
3.	*Bruguiera sexangula-Nypa fruticans* community	7.1±0.28	20.08±5.49	0.51=0.81	67.51±9.75	59.30±6.50	4.57±0.57	20.69±2.32	87.43±16.42	132.46±83.64	1.56±0.23	0.14±0.11	44.25±23.39	55.61±23.40	clay

* and ** significant difference among three forest communities at $P < 0.05$ and $P < 0.01$ respectively according to analyses of variance.

position process of organic matter on sites further from the sea edge. It is probably due to the decreasing frequency of inundation of the sites toward inland so that the soils are rather stable and more or less well-drained. Ponnamperuma (1972) stated that the accumulation of ammonia in anaerobic soils is due to the lack of oxygen to carry the oxidation from nitrite to nitrate, and so the mineralization of organic nitrogen in these soils stop at the ammonia stage. Furthermore, Broto (1984) reported that if anaerobic soil has a pH greater than 7.0 ammonia volatilization might take place through a denitrification process resulting in severe losses of nitrogen from the soils.

There was a significant difference among the three forest communities for eight soil characteristics such as pH, C-organic, N-total, % K, % Na, NH_4, CEC, and EC (Table 2). These soil characteristics appeared to be important in influencing the occurrence pattern of mangrove forest communities in Talidendang Besar. Based on a statistical test using least significant difference (Table 3), the values of C-organic, CEC, EC, % K, and % Na were significantly different between forest communities, but the contents of N and NH_4 were only significantly different between the *B. parviflora* and *B. sexangula-N. fruticans* communities. Meanwhile, the pH of the soils was significantly different among the three forest communities, except between the *B. parviflora* and *B. sexangula* community. If the three mangrove forest communities were ranked according to their relative positions with regard to these important soil characteristics (Table 4), the *B. parviflora* community tends

Table 3. Least significant difference (LSD) test for soil characteristics showing significant difference among three forest communities

No.	Soil characteristics	Community type		
		1 vs 2	1 vs 3	2 vs 3
1.	PH	ns	**	*
2.	C-organic	**	**	**
3.	N-total	ns	*	ns
4.	NH_4	ns	*	ns
5.	% K	**	**	**
6.	% Na	**	**	**
7.	CEC	**	**	**
8.	EC	*	**	*

- Community type 1: *Bruguiera parviflora* community
- Community type 2: *Bruguiera sexangula* community
-Community type 3: *Bruguiera sexangula-Nypa fruticans* community
* significant difference at $P < 0.05$
** significant difference at $P < 0.01$
ns non-significant.

Table 4. Relative position of three forest communities ranked according to mean values of eight important soil characteristics

Rank	Soil characteristics							
	pH	C-org.	N-total	*K	%Na	CEC	NH_4	EC
1	BP	Bs-Nf	Bs-Nf	Bp	Bp	Bs-Nf	Bs-Nf	Bp
2	Bs	Bs	Bs	Bs	Bs	Bs	Bs	Bs
3	Bs-Nf	Bp	Bp	Bs-Nf	Bs-Nf	Bp	Bp	Bs-Nf

Bp : *Bruguiera parviflora* community
Bs : *Bruguiera sexangula* community
Bs-Nf : *Bruguiera sexangula-Nypa fruticans* community.

to occupy soils which contain higher % Na, % K, EC and pH, and lower C-organic, N-total, NH_4, and CEC compared to the others. On the contrary, the soils occupied by the *B. sexangula-N. fruticans* community contained lower % Na, % K, EC and pH, and higher C-organic, N- total, NH_4, and CEC. The *B. sexangula* community tends to occupy soils which contain intermediate values of these soil characteristics. It means that in Talidendang Besar, *B. parviflora* tends to grow on the rather saline and soft mud clayey soils in the area near the sea edge which is frequently submerged in sea water. *B. sexangula* can grow on various types of mud ranging from rather soft clayey soils in the area near the sea edge to the hard silty clayey soils in the inland area which is infrequently submerged in sea water. *B. sexangula* tends to grow optimally on rather hard silty clayey soil with pH 7.0 in the inland area, while the other species viz *N. fruticans* and *Ficus benjamina* occur in the innermost zone of the mangrove with lower salinity. Yamaha and Sukardjo (1979) reported that in South Sumatera, *B. parviflora* grows in soft mud, while *B. sexangula* grows mixed with *B. gymnorrhiza* and *Rhizophora apiculata* in the innermost zone of mangroves on rather hard mud soil.

CONCLUSIONS

The mangrove forest in Talidendang Besar could be divided into *Bruguiera parviflora* community occupying an area from the sea edge to about 180 m inland, *B. sexangula* community from about 180 m to 740 m inland, and *B. sexangula-N. fruticans* community from about 740 m to 900 m inland. In the *B. parviflora* community, *B. parviflora* was considered the dominant species and *B, sexangula* the codominant one. In the *B. sexangula* community, *B. sexangula* was considered the dominant species and *B. parviflora* the codominant one, while in the *B. sexangula-*

N. fruticans community, *B. sexangula* was considered the dominant species and TV. *fruticans* the codominant one.

There were eight soil characteristics considered important in influencing the occurrence pattern of the mangrove forest community in Talidendang Besar, Riau: pH, EC (electrical conductivity), CEC (cation exchange capacity), C-organic, N-total, NH_4, % K, and % Na.

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