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# SOIL AS A FACTOR INFLUENCING MANGROVE FOREST COMMUNITY OCCURRENCE IN TALIDENDANG BESAR, RIAU

## *(Tanah Sebagai Faktoryang Mempengaruhi Keberadaan Komunitas Hutan Mangrove di Talidendang Besar, Riau)*

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**ABSTRACT**

This study was undertaken to investigate the soils factors influencing the mangrove forest community occurrence in Talidendang Besar, Riau.

One sample plot of 50 m x 50 m was established at *Bruguiera parviflora* community. *B. sexangula* community, and mixed *B. sexangula - Nypa fruticans* community to explore its vegetation composition and soil characteristics.

The soil factors such as pH, EC (electrical conductivity), % K, Na, C-organic, N-total, NH4 (ammonia), and CEC (cation exchange capacity) were regarded as soil factors to be important in influencing the occurrence pattern of mangrove forest community in Talidendang Besar. Riau.

***Keywords: mangrove, Talidendang Besar, Riau, forest community.***

## INTRODUCTION

Darsidi (1987) reported that the mangrove forest in Indonesia covers an area of approximately 4.25 million ha, where about 276,000 ha of which distributed in Riau. Most of the mangrove forest 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 the mangrove swamps, but the most important are soil type, salinity, drainage, and water currents (Chapman, 1975). Furthermore, Steenis (1958) stated that soil type is more important than the others in controlling the zonation of mangroves. In any area if the climate is fairly uniform, chemical differences in the soil may produce a marked change in the vegetation (Billings, 1950).

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

The present study was aimed to investigate the soil factors influencing the occurrence of mangrove forest community in Talidendang Besar. Riau. It is hoped that the results of this research may contribute to establish proper management of the mangrove forest in Indonesia.

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## MATERIALS AND METHODS

This research was conducted in mangrove forest concession area at Talidendang Besar belongs to PT Bina Lestari which is located at Kateman Distric, Indragiri Hilir Regency, Riau Province. Geographically, this mangrove forest area is located at the east coast of Sumatera with gently topography and altitude 0 - 3 m above-sea-level between Long. 103° 28' to 103° 48' E and Lat. 0° 21' to 1° N (Fig. 1). According to Schmidt and Ferguson system (1951), based on rainfall data of Tembilahan (Badan Meteorologi dan Geofisika, 1990) the research's area is covered by B climate type with seven wet months, two dry months, and three humid months. While the soils of this area is organosol and glei humus (Lembaga Penelitian Tanah, 1964).

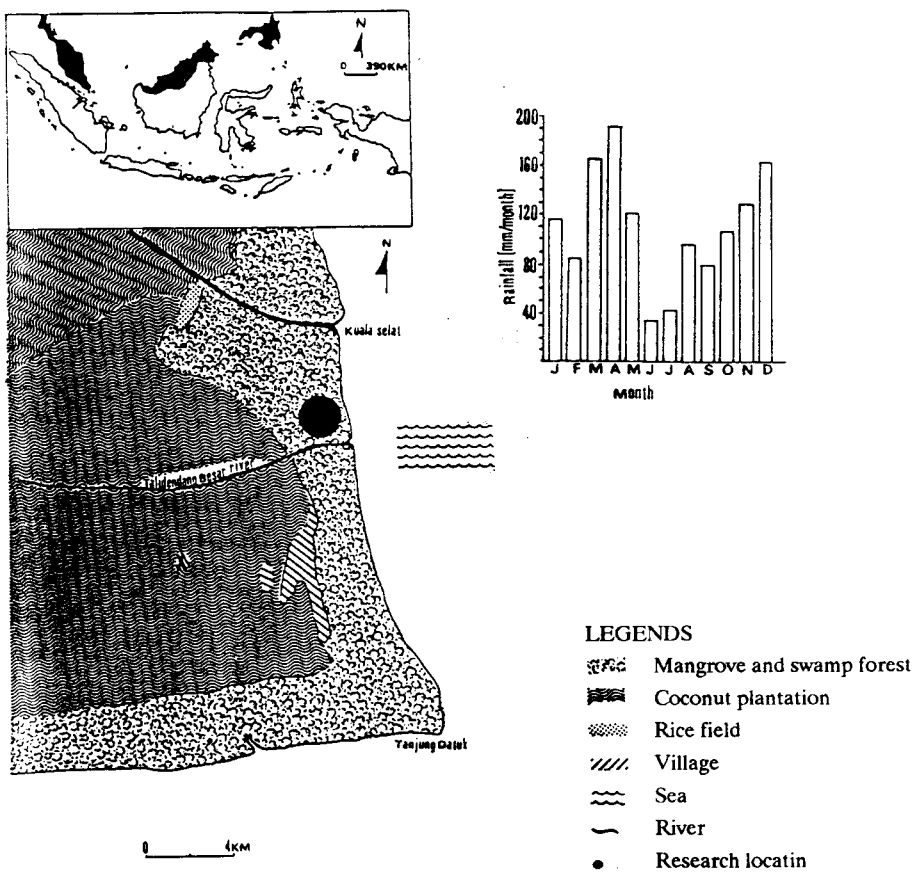


Figure 1. Location and the climatic diagram of the mangrove forest area of Talidendang Besar, Riau

Based on reconnaissance, the mangrove forest in Talidendang Besar was arranged by *Bruguiera parviflora* community, *B. sexangula* community, and mixed *B. sexangula - Nypa fruticans* community which were laid out from seacoast through inland respectively. One sample plot of 50 x 50 m was established at each forest community to explore its vegetation composition and soil characteristics. This sample plot was devided into 10 x 10 m subplots completely. The diameter and height of the trees with DBH (diameter at breast height) 10 cm up within subplots were recorded. Four soil samples down to the depth of 25 cm were collected randomly from the area within each adjacent sample plot of 50 x 50 m. Each soil sample was analysed for texture, pH, C-organic, EC (electrical conductivity), CEC (cation exchange capacity), N-total, $NH_4$ (ammonia), and exchangable cations (K, Na, Mg, Ca) at the soil laboratory of Faculty of Agriculture, Bogor Agricultural University.

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

## RESULTS AND DISCUSSION

### A. Vegetation Composition

Table 1 shows that in *B. parviflora* community, *B. parviflora* was considered as dominant species and *B. sexangula* as codominant species. The opposite feature that in *B. sexangula* community, *B. sexangula* was considered as dominant species and *B. parviflora* as codominant species. While in *B. sexangula-N. fruticans* community, *B. sexangula* was considered as dominant species and *N. fruticans* as codominant species.

Table 1. Density, basal area, importance value index (IVI), average height and diameter of tree in the sample plots at three forest communities in mangrove forest of Talidendang Besar, Riau

| Community type | Species | Density (ind./ha) | Basal area ($m^2$/ha) | IVI (%) | Average Height(m) | Average Diameter(cm) |
|---|---|---|---|---|---|---|
| 1. *B. parviflora community* | *B. parviflora* | 392 | 8.190 | 171.95 | 19.4 | 15.9 |
| | *B. sexangula* | 200 | 6.790 | 128.05 | 17.7 | 19.9 |
| 2. *B. sexangula community* | *B. parviflora* | 164 | 4.060 | 100.12 | 19.8 | 17.4 |
| | *B. sexangula* | 300 | 14.470 | 199.89 | 20.2 | 23.3 |
| 3. *B. sexangula-N. fruticans community* | *B. parviflora* | 8 | 0.070 | 8.33 | 13.2 | 10.1 |
| | *B. sexangula* | 340 | 20.220 | 199.93 | 23.1 | 26.1 |
| | *R. apiculata* | 16 | 2.240 | 22.26 | 32.1 | 41.8 |
| | *F. benjamina* | 4 | 0.040 | 4.17 | 6.5 | 11.0 |
| | *N. fruticans* | 56 | 14.800 | 65.31 | 7.5 | 75.5+ |

+ Diameter of clump

There is marked tendency that the density and basal area of *B. parviflora were decreased from seaedge (B. parviflora* community) to the inland (*B. sexangula-N. fruticans* community), but the density and basal area of *B. sexangula* tended to increase onward inland area. In addition, more further from seaedge, the tree species richness was more various. It is suggested due to less severe site condition in the area onward inland which can give chance for many species to grow on its. Johnstone (1983) stated that the presence of terrestrial species in the back zone of mangal is considered to be more indicative of the salinity regim than representing an active process of colonization from the land as a part of an integrated succesional system.

## B. Forest Community Occurrence as Related to Soil Factors

According to Table 2, the soils which occupied by each forest community has high percentage of clay, intermediate percentage of silt, and low percentage of sand. It indicates that the mangrove forest area in Talidendang Besar receive much soil- eroded which contains high finer soil particles through 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 by comer people mainly Bugis people who came from the south part of Sulawesi island. The soils was covered either by *B. parviflora* community or *B. sexangula* community classified as clay, while the soils was covered by *B. sexangula-N. fruticans* community classified as silty clay. The soils of this mangrove forest area was almost the same as the soils of the mangrove forest area in Ujung Karawang, Cilacap (Al Rasyid, 1971; Soerianegara, 1971), and Bengkalis (Dinas Kehutanan Propinsi Dati I Riau, 1978).

Table 2. Soil properties occupied by each mangrove forest community in Talidendang Besar, Riau

| No. Soil Properties | Community type | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 1. pH* | 7.45 (0.18) | 7.40 (0.19) | 7.09 (0.28) |
| 2. C-org**(%) | 4.17 (0.64) | 10.68 (3.32) | 20.08 (5.49) |
| 3. N-total*(%) | 0.21 (0.03) | 0.36 (0.05) | 0.51 (0.81) |
| 4. %Ca | 78.15 (16.77) | 74.98 (5.35) | 67.51 (9.75) |
| 5. %Mg | 66.62 (23.56) | 65.32 (8.92) | 59.30 (6.50) |
| 6. %K** | 8.08 (0.22) | 6.36 (0.48) | 4.57 (0.57) |
| 7. %Na** | 32.93 (0.18) | 23.97 (1.99) | 20.69 (2.32) |
| 8. CEC**(me/100g) | 39.33 (1.19) | 59.13 (9.94) | 87.43 (16.42) |
| 9. Sand (%) | 0.15 (0.09) | 0.07 (0.05) | 0.14 (0.11) |
| 10. Silt (%) | 37.75 (6.09) | 33.84 (5.36) | 44.25 (23.39) |
| 11. Clay (%) | 62.10 (6.16) | 63.98 (6.25) | 55.61 (23.40) |
| 12. EC**(mmS/cm) | 2.06 (0.11) | 1.80 (0.22) | 1.56 (0.23) |
| 13. $NH_4$*(ppm) | 36.54 (14.38) | 74.78 (17.56) | 132.46 (83.64) |
| 14. Texture class | Clay | Clay | Silty clay |

Community type 1 : *Bruguiera parviflora* community
Community type 2 : *Bruguiera sexangula* community
Community type 3 : mixed *Bruguiera sexangula-Nypa fruticans* community
Values on the table are mean (95% confidence limit).
* and ** Letters superscript indicate significant difference among three community types at the level of $P < 0.05$ and $P < 0.01$, respectively.

The pH of the soils was covered by each forest community generally considered as arround neutral with tendency to converge 7.0 onward inland due to the decreasing of percentage of exchangable cations content in the soils from seaedge through inland area. The similar appearance that the salinity (electrical conductivity) in the soils tends to decrease onward inland, but generally the salinity of the soils occupied by each forest community was considered as low, and the adsorption site of the soils dominated by cations in the order of Ca > Mg > Na > K. It is suggested due to the mangrove forest in this area receive much fresh water through stream flow of Talidendang Besar river, while the area onward inland was infrequently submerged by seawater.

C-organic, $NH_4$ (ammonia), N-total, and CEC (cation exchange capacity) were increased onward inland. It indicates that onward inland area the organic matter and the decomposition process of its tend to increase. It is probably correlated to the maturity stage of the trees and the soil substrate condition on these forest communities. According to the data of average height and diameter of the trees in these forest communities (Table 1), there is the tendency that onward inland area, the forest community occupied by more mature trees, so the amount of litter fall to the forest floor suggests to be more larger in the forest community onward inland. In addition, the dense of aerial roots on the floor in the *B. sexangula* community and *B. sexangula-N. fruticans* community play an important role in trapping leaves and debris during tidal inundation, thereby contributing to high organic matter on these forest communities. Increasing content of N and $NH_4$ on the soils were covered by forest community onward inland indicates more rapid decomposition process of organic matter on the site more further from the seacoast. It is probably due to the decreasing frequency of inundation on the sites onward inland, so the soils is rather stable and more or less rather well-drained. Ponnamperuma (1972) stated that the accumulation ammonia in anaerobic soils due to the lack of oxygen to curry the process via nitrite to nitrate, so that the mineralization of organic nitrogen in these soils stop at ammonia stage. Furthermore, Broto (1984) reported that if anaerobic soil has a pH greater than 7.0, it is possible that ammonia volatilization via denitrification process, with a resulting severe losses of nitrogen from the soils.

There was a significant difference among 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 community in Talidendang Besar. According to the further test using least significant difference (Table 3), the difference content on the soils of C-organic, CEC, EC, % K, and % Na were significant between forest communities, but the content of N and $NH_4$ were only significantly difference between *B. parviflora* community and *B. sexangula-N. fruticans* community. Meanwhile, the pH of the soils was significantly difference among three forest communities, except between *B. parviflora* community and *B. sexangula* community. If the three mangrove forest communities were ranked according to their relative positions with regard to the these important soil characteristics which they occupied (Table 4), *B. parviflora* community tends to occupy the soils which contained more higher of % Na, % K, EC and pH, and more lower of C-organic, N-total, $NH_4$, and CEC compared to the others. In the

contrary, the soils occupied by *B. sexangula-N. fruticans* community contained more lower of % Na, % K, EC and pH, and more higher of C-organic, N-total, $NH_4$, and CEC. While *B. sexangula* community tends to occupy the soils which contained the 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 nearby seacoast which frequently submerged by seawater, and *B. sexangula* can grow on various types of mud ranging from rather soft clayey soils in the area nearby seacoast until hard silty clayey soils in the inland area which infrequently submerged by seawater. But, *B. sexangula* tends to grow optimally on the rather hard silty clayey soils with pH converged to 7.0 in the inland area. While the other species viz *N. fruticans*, *Ficus benjamina*, and *Rhizophora apiculata* occured in the innermost zone of mangrove with more lower salinity. Yamada and Sukardjo (1979) reported that in South Sumatera, *B. parviflora* grows in rather soft mud, while *B. sexangula* grows mixed with *B. gymnorrhiza* and *Rhizophora apiculata* in the innermost zone of mangroves on the rather hard mud soils.

Table 3. Least significant difference (LSD) test for soil characteristics which 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 where ranked according to mean values for eight important soil characteristics occupied by each.

| 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

## CONCLUSSIONS

In *B. parviflora* community, *B. parviflora* was considered as dominant species and *B. sexangula* as codominant species. In *B. sexangula* community, *B. sexangula* was considered as dominant species and *B. parviflora* as codominant species. While in *B. sexangula-N. fruticans* community, *B. sexangula* was considered as dominant species and *N. fruticans* as codominant species.

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

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