2-3 Lamon Bay area

2-3-1 Natural Conditions

(1) Climate

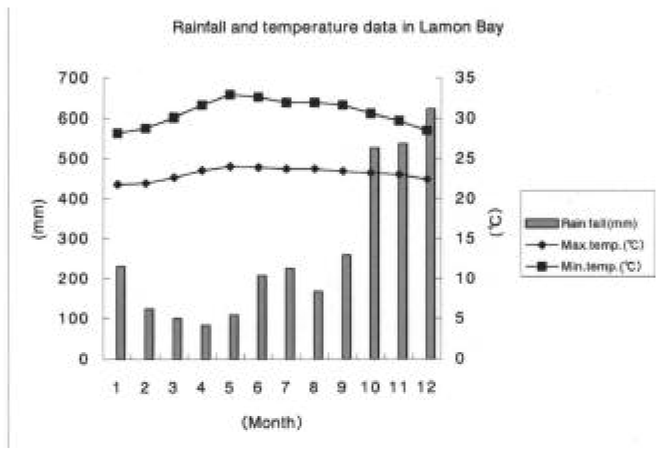


Fig. 2-2L-1 Mean Annual Temperature and Rainfall in Lamon Bay

The Lamon Bay area falls within the eastern coast climatic type. Rain falls throughout the year and there is no distinct dry season. Figure 2-2L-1 shows the maximum and minimum average monthly temperature and rainfall recorded from 1961 to 1996 by the Alabat Meteorological Observatory at Alabat Island situated close to Lamon Bay. 3_/

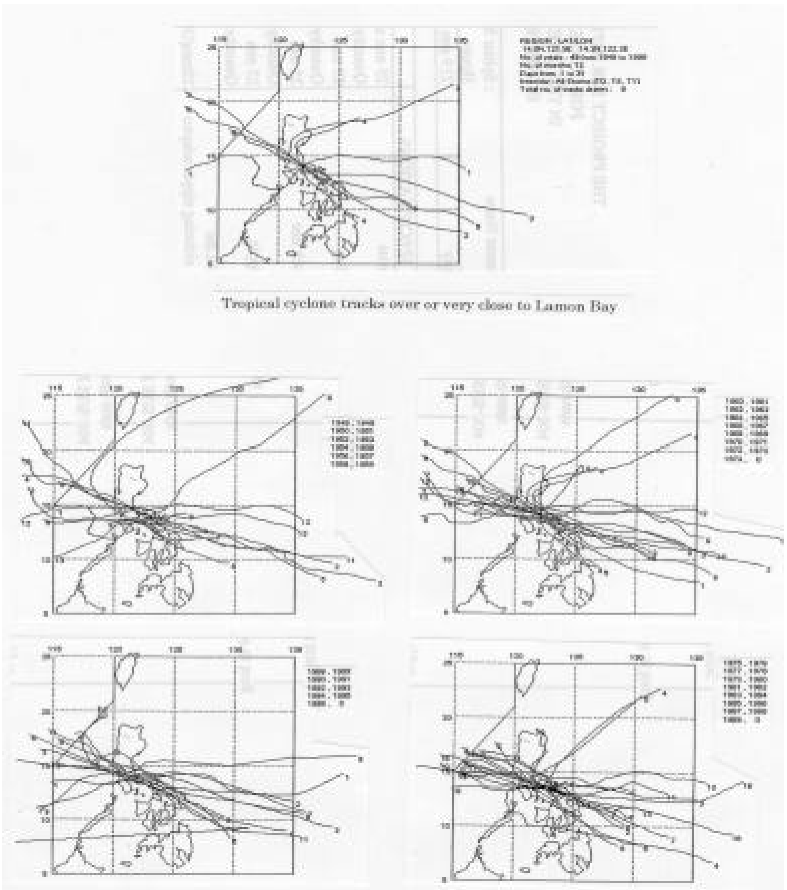


Fig. 2-2L-2 Tropical Cyclone Tracks in Lamon Bay (1948-1996)

From data on Figure 2-2L-1 it is clear that Alabat, and the Lamon Bay area in general, has more rainfall than the two other areas (Aparri and Ulugan). Much of this rainfall is due to tropical cyclones (typhoons). Figure 2-2L-2 is a map prepared by the Observatory charting the course of typhoons in that area. Last 48 years from 1948 to 1996, 173 tropical depressions have experienced within a 100 km radius of Alabat. Ninety-one (91) of these depressions developed into typhoons that accounted for more than half of the total rainfall during the period. The environment along the coast of Lamon Bay is significantly affected by the impact of typhoons. 4_/

(2) Topography and Geology

This area forms part of the Philippines that extends from the southern part of Luzon island, through the islands of Samar, Masbate and Leyte. The topography in and around Lamon Bay is formed by several faults that trend in a northwest-southeast direction. Lopez Bay and Calauag Bay are in the subsidence zone. Alabat Island and the peninsular area between Calauag Bay and Basiad Bay lie in the upheaval zone. Geologically, almost all of the region is formed by marine sediments composed of Paleogene Oligocene-Paleocene and Neogene Miocene-Pliocene wackes (argillaceous sandstones), shales and limestones. Sedimentation of dacite or andesite pyroclastic flows is found in some parts of the area.

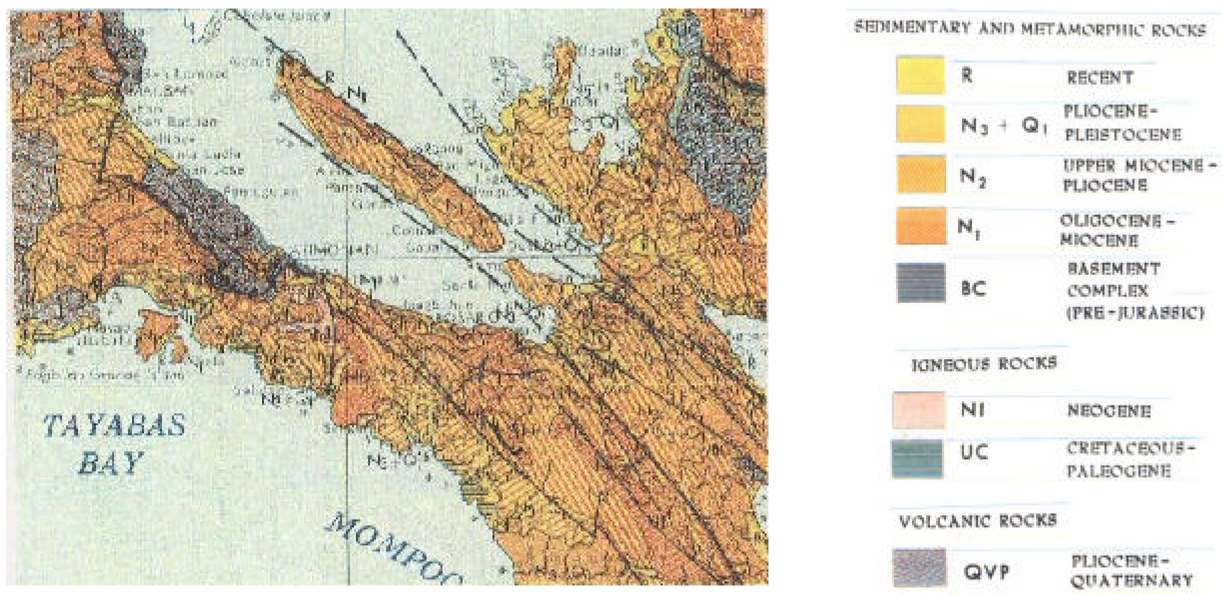


Fig. 2-2L-3 Geological Structure in Lamon Bay Area

Although there are no large rivers comparable to the Cagayan river in the Aparri area, quaternary alluvium spreads over the inner parts of the bay and the relatively flat areas along the coast. Originally, thick mangrove forests thrived in the area. At present however, almost all the dense mangrove forests have been converted into fishponds and farmlands. 5_/

(3) Typology of the Mangrove Habitat

The Lamon Bay area is larger than the Aparri and Ulugan area. It is characterized by a combination of several topographical factors, including bays and capes. No large rivers flow into the area except Kabibihan River which carries an appreciable volume of soil and sand. The site may be classified as a combination of open-accreting coast types and estuary types. Mangroves extend forward the shores of St. Angel Bay, along the Dapdap River, and on small inlets inside Basiad Bay. Since the seawater inside these bays is shallow, the muddy bottom is partially exposed at low tide. Estuary types of mangrove forests are found on these tidelands.

(4) Soil

Soils in the area are characterized by several locational variables. Soil nearest the sea is thin and sandy, but becomes brown or dark-brown and rich in humus on the landward side. The presence of plant residue is apparent even in very deep layers of the soil. This indicates that mangroves contributed significantly to soil development. The uneven thickness of the sandy lower-soil horizon suggests that it was affected by typhoons causing wave action or other water movement at the time of sedimentation. Sedimentation of the mangrove soil is widespread, thus adding another feature which differentiates Lamon Bay from the two other areas.

(5) Result of Soil Survey

1) Soil Research Results in the Lamon Bay Area (1)

The soil sedimentation conditions in the Lamon Bay area are stated below. Figure 2-2L-4 shows the results of the transect survey conducted in the Sta. Cecilia zone. Along the belt transect, soil sampling was conducted with a piston soil sampler, and soil profiles and their conditions observed at 2 plots, namely that 0 m away from the starting point (Plot.1) and that 85 m away (Plot.2).

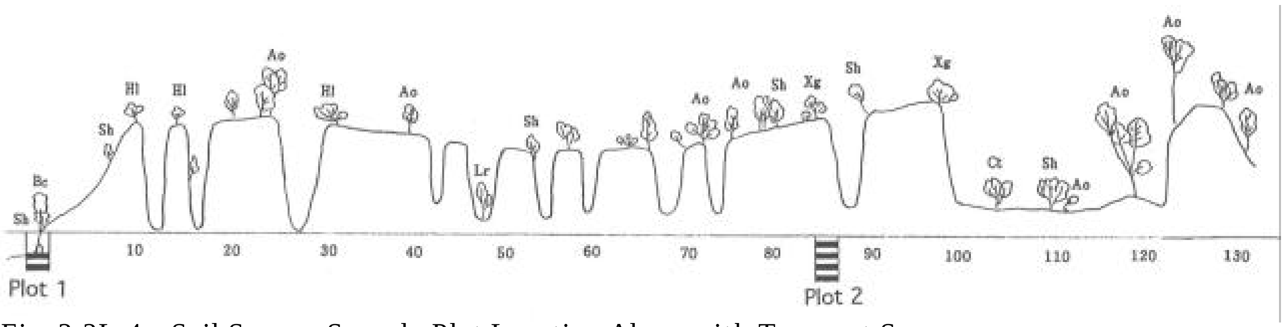


Fig. 2-2L-4 Soil Survey Sample Plot Location Along with Transect Survey

Figure 2-2L-5 shows the soil profile at the point 0 m away from the starting point (Plot.1). *A. officinalis*, *Bruguiera cylindrica* and *Scyphiphora hydrophyllacea* are found on the plot. Though the pis-ton soil sampler could be inserted to the depth of only 90 cm, it is inferred that the whole soil layer is rather thicker. The whole soil layer from the surface to the depth of 90 cm is divided into 3 layers by soil texture and soil color.

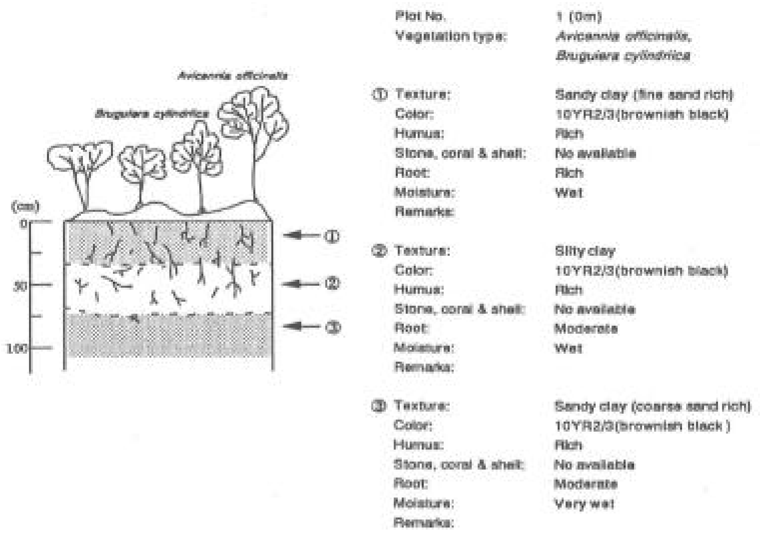


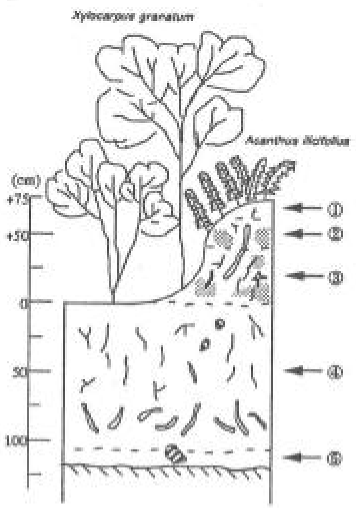
Fig. 2-2L-5 Soil Profile of Plot 1 (Lamon Bay No1)

The top layer is situated from the surface at depth of 30 cm. The soil texture is sandy soil, and is mostly of fine grain size. The soil color is 10YR2/3 (brownish black), and much humus is contained, but no stone, coral or shell fragments are found. A large quantity of roots, which seem to be those of *A. officinalis*, *B. cylindrica* and *S. hydrophyllacea*, are found in the soil layer.

The middle layer is situated at depth of 30 to 70 cm. The soil texture is silty clay, the soil color is 10YR2/3 (brownish black), and much humus is contained, but no stone, coral or shell fragments are found. Roots, which seem to be those of *A. officinalis*, *B. cylindrica* and *S. hydrophyllacea*, are found to some extent in the soil layer.

The bottom layer is situated at depth of 70 cm and below. The soil texture is sand-mixed clay, and the ratio of sand is high. The soil color is 10YR2/3 (brownish black), and much humus is contained, but no stone, coral or shell fragments are found. Roots, which seem to be those of *A. officinalis*, *B. cylindrica* and *S. hydrophyllacea*, are found to some extent in the soil layer. This fact indicates there is alteration of sandy soil and clay strata in this plot.

Figure 2-2L-6 shows the soil profile of the sampling point which is 85 m away from the starting point (Plot.2). *Xylocarpus granatum*, *S. hydrophyllacea* and *A. ilicifolius* are found growing in the area. The soil layer exists at depth of 90 cm from the surface. In this plot, creeks and mounds has developed in all directions, and if the height from the creeks to the mound tops is added, the thickness of the whole soil layer is almost 2 m. The whole soil layer from the mound tops to a depth of 90 cm is divided into 5 layers by soil texture and soil color.



Plot No.	2 (85m)
Vegetation type:	*Xylocarpus granatum, Acanthus sp.*
① Texture:	Sandy soil
Color:	10YR6/4(dull yellow orange)
Humus:	Very poor
Stone, coral & shell:	Nil
Root:	Poor
Moisture:	Dry
Remarks:	
② Texture:	Clay sand
Color:	2.5Y7/4(light yellow) ,in sandy part 7.5YR3/1() ,in clay part
Humus:	Very poor
Stone, coral & shell:	Nil
Root:	Rich (thick root exist)
Moisture:	Little wet
Remarks:	Clay block exist
③ Texture:	Sandy clay
Color:	5YR2/4(very dark reddish brown) ,in clay part 7.5YR5/6() ,in sandy part
Humus:	Very poor
Stone, coral & shell:	Nil
Root:	Rich (thick root exist)
Moisture:	Wet
Remarks:	
④ Texture:	Silt clay (some part sand exist)
Color:	5YR2/1(black)
Humus:	Middle
Stone, coral & shell:	Nil
Root:	Middle
Moisture:	Very wet
Remarks:	Clay block exist
⑤ Texture:	Silt clay
Color:	7.5Y4/1(gray)
Humus:	Very poor
Stone, coral & shell:	Nil
Root:	Nil
Moisture:	Very wet
Remarks:	

Fig. 2-2L-6 Soil Profile of Plot 2 (Lamon Bay No1)

The top layer is situated from the mound tops at the height of 65 cm. The soil texture is sandy soil, the soil color is 10YR6/4 (dull yellow orange), little humus is found, and no stone, coral or shell fragments are found, either. Very few roots are found.

The second layer is situated at the height of 65 to 35 cm. The soil texture is clay-mixed sandy soil, but clay blocks are observed in some parts of it. The soil color of the sandy soil is 7.5YR3/1 (brownish black), and that of the clay blocks 2.5Y7/4 (light yellow). Little humus is found, and no stone, coral or shell fragments are found, either. Also few roots are found.

The third layer is situated from the height of 35 cm from 0 cm, namely the level of the creek beds. The soil texture is clay-mixed sandy soil, but clay blocks are observed in some parts of it, as well as in the second layer. The soil color of the sandy silt is 7.5YR5/6 (bright brown), and that of clay blocks 5YR2/4 (reddish brown). Little humus is found, and no stone, coral or shell fragments are found, either. A large quantity of roots are found, and especially thick roots are also found.

The fourth layer is situated at depth of 0 to 105 cm from the ground surface. The soil texture is silty clay, but clay blocks are observed in some parts of it. The soil color is 5YR2/1 (black), humus is contained, and no stone, coral or shell fragments are found. Roots are found to some extent in the soil layer.

The bottom layer is situated at depth of 105 to 120 cm. The soil texture is silty clay, the soil color is 7.5Y4/1 (gray), very little humus is contained, and no stone, coral or shell fragments are found. No roots are found in this depth.

Alteration of sandy soil and silty clay strata is a feature in this sampling plot as well as in Plot.1 and Plot.2. This fact indicates that periods when soil flow was so swift that comparatively large-grain-sized sandy soil was accumulated and those when soil flow was so gentle that small-grain-sized silt and clay were accumulated came alternately in the Sta. Cecilia zone It is inferred that big events like typhoon raids may have contributed to the creation of these strata.

2) Soil Research Results in the Lamon Bay Area (2)

Figure 2-2L-7 shows the results of the transect survey conducted in the Binactocan zone in the Lamon Bay area. Along the belt transect in the zone, soil profiles and their conditions were observed at 3 plots, namely the 20 m away from the starting point (Plot.1), that 135 m away (Plot.2), and that 195 m away (Plot.3).

Figure 2-2L-8 shows the soil profile at sampling point 20 m away from the starting point (Plot.1). *A. officinalis*, *Avicennia marina* and *Rhizophora apiculata* are found in the sampling plot. The whole soil layer is about 100 cm in depth, and is divided into 3 layers by soil texture and soil color.

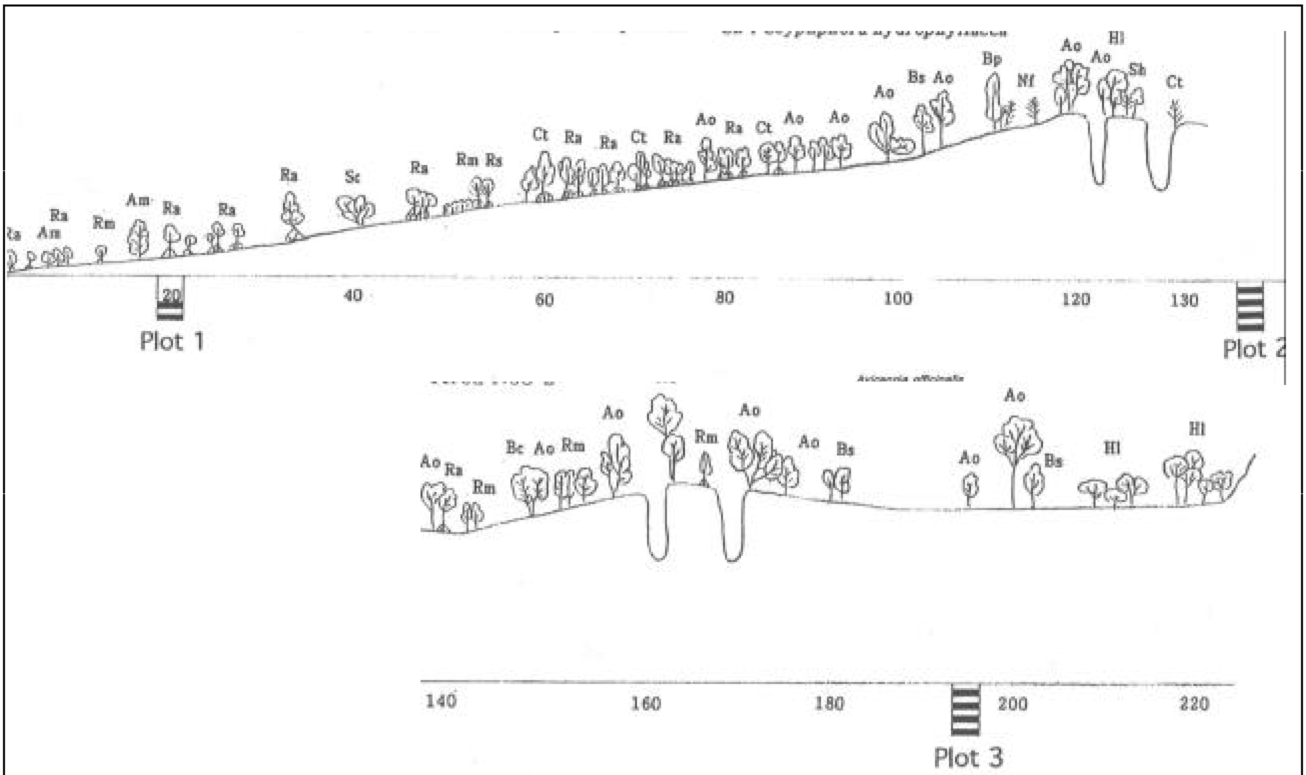


Fig. 2-2L-7　Soil Survey Sample Plot Location Along with Transect Survey

The top layer is situated from the surface at depth of 20 cm. The soil texture is sandy silt, and sand mostly of fine grain size. The soil color is 7.5YR2/2 (brownish black), and humus is contained, no stone, coral or shell fragments are found.　Roots, which seem to be those of *A. officinalis*, *A. marina* and *R. apiculata* , are found in the soil layer.

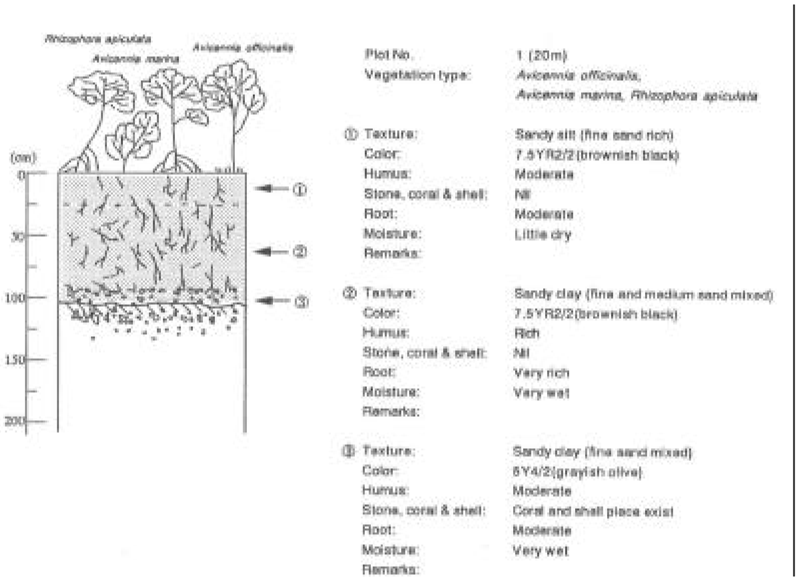


Fig. 2-2L-8　Soil Profile of Plot 1(Lamon Bay No2)

The middle layer is situated at depth of 20 to 90 cm. The soil texture is sand-mixed clay, the soil color is 7.5YR2/2 (brownish black), and much humus exist, but no stone, coral or shell fragments are found. A remarkably large quantity of roots, which seem to be those of *A. officinalis*, *A. marina* and *R. apiculata*, are found in the soil layer.

The bottom layer is situated at depth of 90 to 100 cm. The soil texture is fine-grain-sand-mixed clay, the soil color is 5Y4/2 (grayish olive), which humus is content. Coral and shell fragments are found in the soil layer. Roots are found to some extent in the soil layer.

Figure 2-2L-9a shows the soil profile of the point 135 m away from the starting point (Plot.2). *R. apiculata*, *A. officinalis* and *Ceriops tagal* are found growing in the sampling plot. The whole soil layer is more than 250 cm in depth, and is divided into 2 layers by soil texture and soil color.

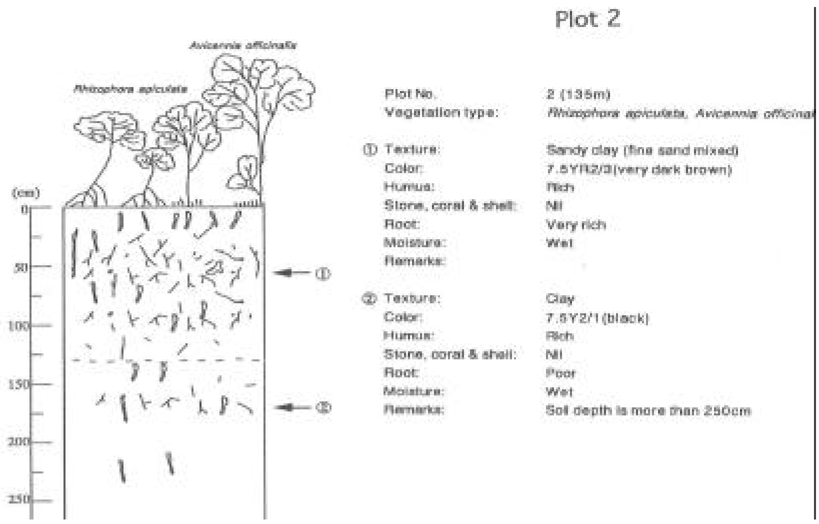


Fig. 2-2L-9 Soil Profile of Plot 2 (Lamon Bay No2)

The upper layer is situated from the surface to the depth of 130 cm. The soil texture is fine-grain-sand-mixed clay, the soil color is 7.5YR2/3 (very dark brown), and high quantity of humus, but no stone, coral or shell fragments are found. A remarkably large quantity of roots, which seem to be those of *R. apiculata*, *A. officinalis* and *C. tagal*, are found in the soil layer.

The lower layer is situated at depth of 130 cm and below. The soil texture is clay, the soil color is 7.5Y2/1 (black), and large amount of humus is contained, but no stone, coral or shell fragments are found. remarkably many roots, which seem to be those of *R. apiculata*, *A. officinalis* and *C. tagal*, are found in the soil layer.

Figure 2-2L-9b shows the soil profile at point 195 m away from the starting point (Plot.3). *Bruguiera sexangula*, *A. officinalis*, *Acrostichum aureum* and *A. ilicifolius* are found in the sampling plot. The whole soil layer is 110 cm depth, and is divided into 2 layers by soil texture and soil color.

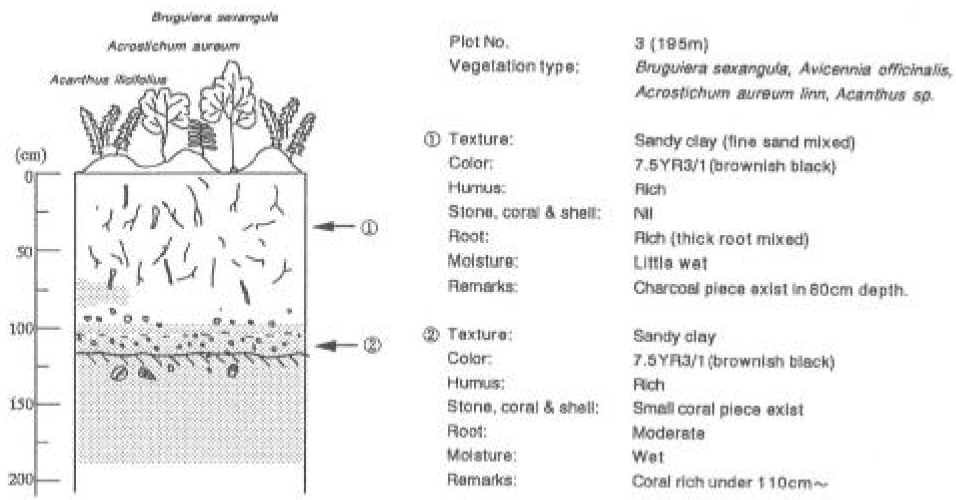


Fig. 2-2L-9b Soil Profile of Plot 3 (Lamon Bay No2)

The upper layer is at the depth of 105 cm. The soil texture is fine-grain-sand-mixed clay, the soil color is 7.5YR3/1 (brownish black), much humus is contained, and no stone, coral or shell fragments are found. A remarkably large quantity and thick roots, which seem to be those of *B. sexangula* and *A. officinalis*, are found in the soil layer.

The lower layer is at depth of 105 to 110 cm. The soil texture is also sand-mixed clay, the soil color is 7.5YR3/1 (brownish black), large humus contents, and small-sized coral fragments found. Roots are also found to some extent. Because the layer at depth of 110 cm and below is filled with coral fragments and large-grain-sized sand, the piston soil sampler could not be inserted deeper.

Soil sedimentation structure in the Binactocan zone, the soil layer is thin in the seaward (about 100 cm in sampling Plot.1), and the layer is getting thicker toward the inland, being the thickest around halfway (more than 250 cm in Plot.2). The layer is getting thinner towards inland (about 110 cm in Plot.3), and in the inland area no mangroves grow. It is inferred from the fact described above that the soil sedimentation structure in the zone is, so to speak, lens-shaped sedimentation, where the center is thick and thin at both ends.

2-3-2 Mangrove Forest Distribution and Features

Lamon and Basiad Bays are on the Pacific Ocean side of the southern part of Luzon island. Most of the area were formerly mangrove forest. Conversion to fishponds has radically changed the landscape especially in the vicinities of Calauag, Makahadok, Kabibihan and Tinagong Bay, paticularly part of Basiad Bay near the national road. The only remaining areas of original mangrove forest are found at the edges of Santo Angel Bay near Pangahoi at the tip of the peninsula and around the mouth of the Dapdap River.

In the conduct of the study, the team divided the Lamon Bay site into nine zones. The east coast of Basiad Bay comprises two zones - (1) Basiad and (2) Makahadok, while the east coast of Calauag Bay was divided into four zones: (3) Tiniguiban, (4) Santo Angel Bay, (5) Santa Cecilia and (6) Binactocan. Three zones are located along the national road; (7) Lopez, (8) Calauag and (9) Kabibihan River. Boundaries of the zones are shown in Appendix 2-8.

The Basiad Zone is topographically a seaside flat on the western side of the peninsula with mangroves extending along the coastline at widths varying from 100 to 500 meters. Short stands of *R. apiculata* begin near the end of the peninsula and extend to a tidal flat located along Tinagong Dagat Bay on the eastern side of the peninsula. On the eastern side of the peninsula there is a typical mangrove lagoon forest in the vicinity of Tinagong Dagat Bay. Fishponds have been constructed on the east side of the bay where fishpond dikes stretch in a continuous line along the coast behind a 5 to 10 meter wide belt of mangrove trees.

In the Makahadok Zone, mangrove forests grow inward from the banks of the Dezor, Caytalapa and Makahadok rivers. Fresh water is mixed with seawater in this zone, thus making it suitable for fishpond construction and development of the large fish farming. Due to the extensive conversion to fishponds, the only remaining mangrove forest consists of narrow belts protecting the coastline, bushy high inter-tidal mangroves, and trees growing at the river mouths. Typhoons have caused extensive damage to some fishponds resulting in financial losses to their owners leading to abandonment of the ponds. These areas would be good target sites for implementation of mangrove rehabilitation program.

The two zones of Tinigiban and Santo Angel Bay have the largest remaining mangrove forest in the Lamon Bay area. Although modest-sized fishponds are found along the small rivers, the likelihood that large-scale development would occur there seems remote. Mangrove forests have regenerated well despite widespread and serious degradation due to firewood collection. Assuming that adequate controls are put in place to prevent further conversion, there would be good prospects for preserving a healthy mangrove ecosystem in these areas. At the present time however, there are very few tall mangrove trees at Tiniguiban and Santo Angel Bay. Starting at the seaward edge of the mangroves, there are dense stands 100 m to 300 m wide consisting of short *R. apiculata* mixed with fairly large numbers of *C. tagal, B. gymnorrhiza, B. parviflora* and *B.a sexangula*. Further landward, there are stands of *A. officinalis* over 10 meters high, dotted with mixtures of *B. parviflora, B. cylindrica, S. alba* and *C. tagal* with *X. granatum* comprising the lower layer.

The two zones of Santa Cecilia and Binactocan have mangrove forest areas extending in a belt on a narrow flat on the eastern side of Calauag Bay. Small fishponds have been constructed along the streams. Large stumps of *S. alba* can often be found in the seaward pioneer area of these zones. Scattered stands of *S. alba* have survived or regenerated. Moving landward, these are followed by a shrub-like zone of *Rhizophora* and *Bruguiera* behind which grow medium-sized stands of *A. officinalis* ranging from 6 to 8 meters high, and short, dense stands of *B. gymnorrhiza, B. sexangula* and *C. tagal*. Further landward, these are replaced by a high inter-tidal mangrove zone composed of *S. hydrophyllacea, H. littoralis* and *X. granatum* mixed with terrestrial bushes which extend up to the coconut groves on dry land.

Lopez and Calauag zones are near a densely-populated town. Mangrove forest areas are confined principally to belts several meters wide that have been conserved along fishpond dikes and small rivers. Most of the former mangroves in the Calauag Zone have been converted to fishponds and the remaining mangrove area is largely occupied by nipa. Additionally however, there is a remaining strip of mangroves 100 to 200 meters wide on the coast. Within this strip, mixed stands of *R. apiculata, R. mucronata, R. stylosa, A. marina* and *S. alba* grow on the seaward edge. Then, 30 to 50 meters landward, they give way to stands dominated by *A. officinalis* with relatively large crowns and heights of 8 to 10 meters growing above short species common in the high-inter-tidal zone such as *X. granatum* and *A. corniculatum*. Moving further toward the land, there is a narrow zone of nipa and bushes including *E. agallocha*, followed by a swamp populated by *A. aureum* that extends to the adjacent farmland.

The Kabibihan River zone presents a different landscape because the river it does not flow into Lamon Bay and has a relatively high rate of flow. The vegetation structure of the Kabibihan zone is rather similar to vegetation at the Aparri area. There are also many fishponds in this zone, where only limited mangrove forests remain. Forests along the river are often dominated by *N. fruticans*. Mangrove trees that have escaped conversion comprise a narrow winding belt of *R. mucronata* on the riverbank. Almost all large trees have been removed. Beside the belt, there are small stands growing 10 to 30 meters from the river bank that consist of *A. officinalis* and *A. lanata* in the upper layer, and *A. corniculatum*, *E. agallocha*, *S. alba* and *S. hydrophyllacea* in the lower layer.

Figures 2-2L-10, 2-2L-15, 2-2L-19, and 2-2L-22 present results of some of the transect surveys conducted at the area. The purpose

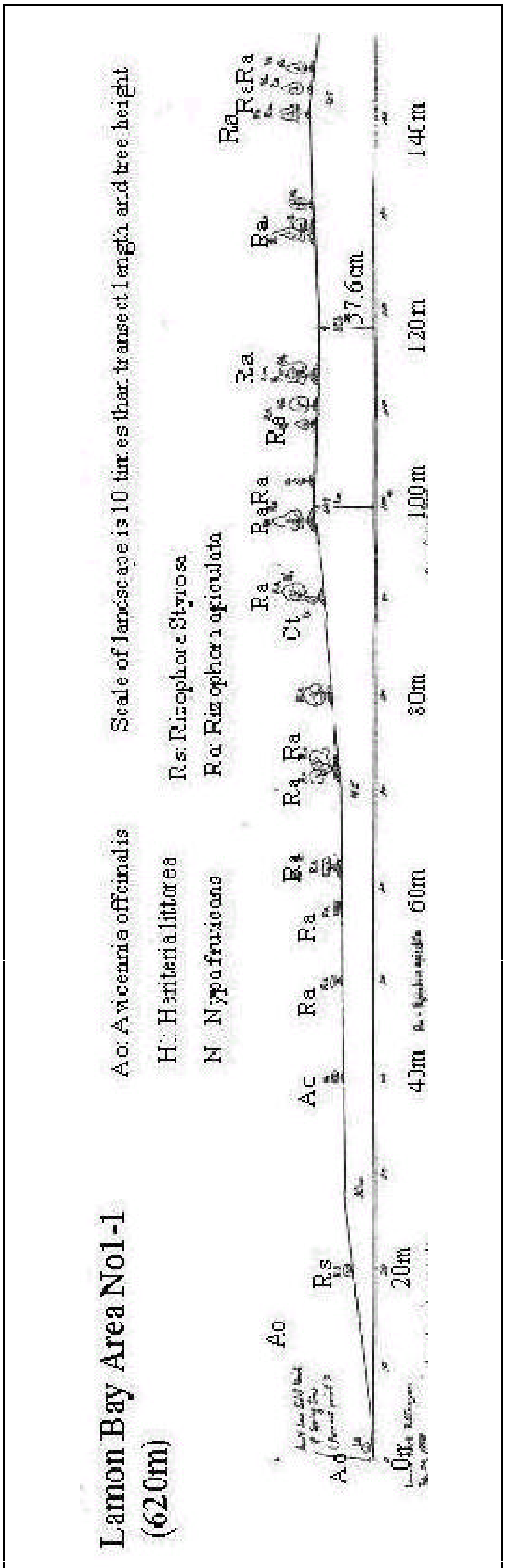


Fig. 2-2L-10(1) Result of a Transect Survey in Lamon Bay Area (Binactocan) of the surveys was to examine the relationship between changes in the tide level and the development of mangrove forests. The survey covered a relatively wide mangrove forest in the seaside areas. The location of these transect survey points are shown on Figure 2-2L-58.

The transect line shown on Figures 2-2L-10 (1), (2) and (4) extended some 620 meters outward from the shore, corresponding with the width of the forest. The ground level follows a slowly-undulating pattern along the transect line. While the species composition varies at different points along this line, the changes are not abrupt nor are they very clear. The sea bottom along the first 100-meters of the transect is exposed at low tide. This area comprises the pioneer zone of the mangrove forest, consisting of scattered clusters of short *A. officinalis, R. stylosa* and *R. apiculata*.

Many short trees grow in gregarious stands at an elevation about 50 cm higher than the starting point of the transect. *R. apiculata* forms the largest component of this community. The elevation of the transect continues at almost the same level until it reaches 260 meters from the start, at which point there is a small stream running in the approximately the same direction that

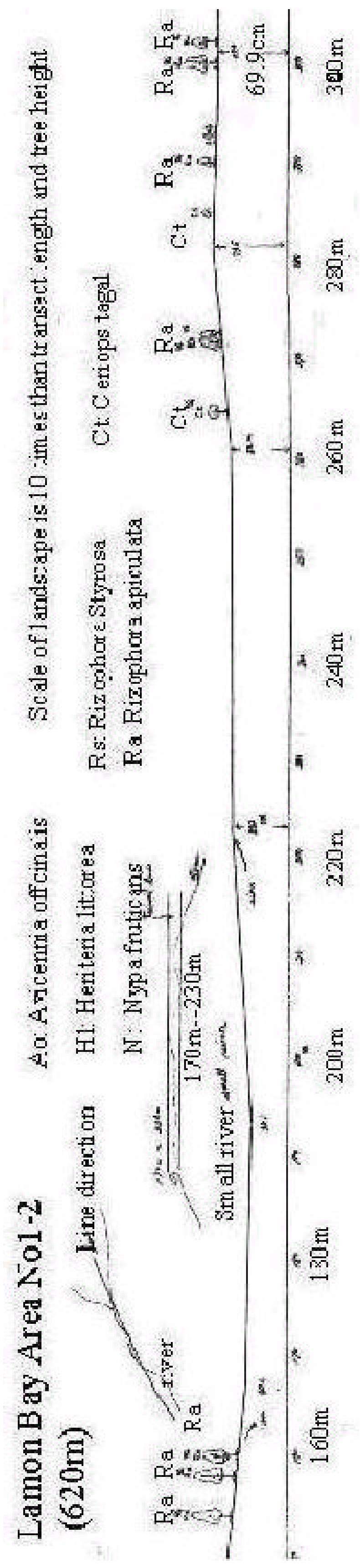


Fig. 2-2L-10(2) Result of a Transect Survey in Lamon Bay Area (Binac-tocan) does not cross the transect line. The vegetation along this section of the transect line is dominated by short *R. apiculata* ranging in height from 1 to 2 meters. Moving further towards the land, tree height increases to 4 to 6 meters, probably because these are older. (Figure 2-2L-10(2)).

At between 220-260 meters from the starting point, open spaces are found alongside the channel of the stream, probably because flow in the channel makes it difficult for seeds to take root. Where the floor height exceeds 50 cm, *C. tagal* are found growing together with *R. apiculata*. The *C. tagal* becomes more dominant wherever there is an increase in the percentage of silt sediment in the soil.

The middle inter-tidal level begins at around 370 meters from the starting point. At 430 meters, the ground dips slightly because the transect line passes a water channel. Trees of *A. officinalis* 6 to 10 meters tall are scattered in the upper layer and inter-spaced by *S. hydrophyllacea* growing at a relatively-high density in the lower layer. Although dominated by *R. apiculata*, the forests along this section of the line have a different structure from the vegetation at the outermost seaward fringe. Elevation of the transect line in this

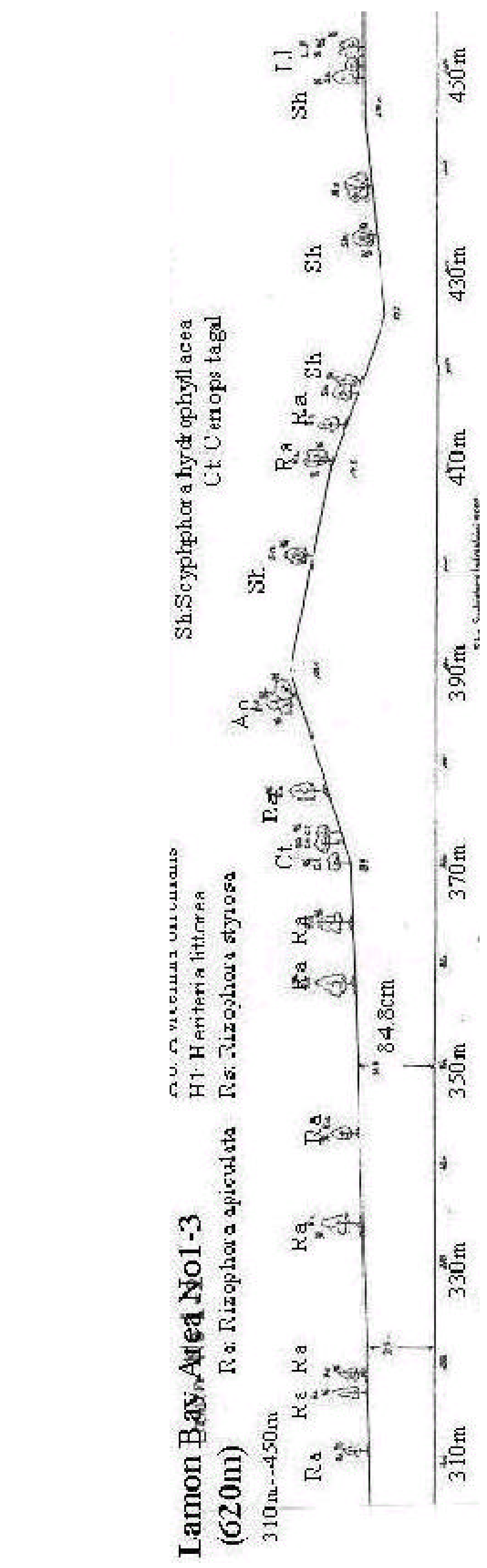


Fig. 2-2L-10(3) Result of a Transect Survey in Lamon Bay Area (Binactocan)(310-460m) area is around 80 cm higher than the starting point.

At around 470 to 500 meters, the elevation increases to more than 100 cm, and the forest floor is submerged for only a short time at high tide. Here, *R. apiculata* almost disappears as the dominant species in the lower level and is replaced by *C. tagal*, *B. sexangula* and *S. hydrophyliacea*. *H. littoralis* trees 6 to 10 meters tall comprise the upper level of the canopy.

Mangrove forests in the seaside and tidal flat areas of the Lamon Bay site are generally composed of short *R. apiculata* vegetation. Data obtained from a plot survey in these forests are presented in Figure 2-2L-11. The plot was located on the seaward side of the inter-tidal flat area in Tinagong Dapat Bay in the Buguay Zone.

In this plot, *R. apiculata* ranging from 2 to 4 meters height grow in dense, rather gregarious stands, mixed however with occasional *R. mucronata* and *B. gymnorchiza*. Some trees attain a DBH of 10 cm but none grow very tall. The crown density of these short forests is around 90%. The area represented by this plot has thick growths of short mangrove trees except on a few water channels. Data on the stand structure in this plot are shown in Table 2-2L-1 and on Figures 2-2L-12 and 2-2L-13.

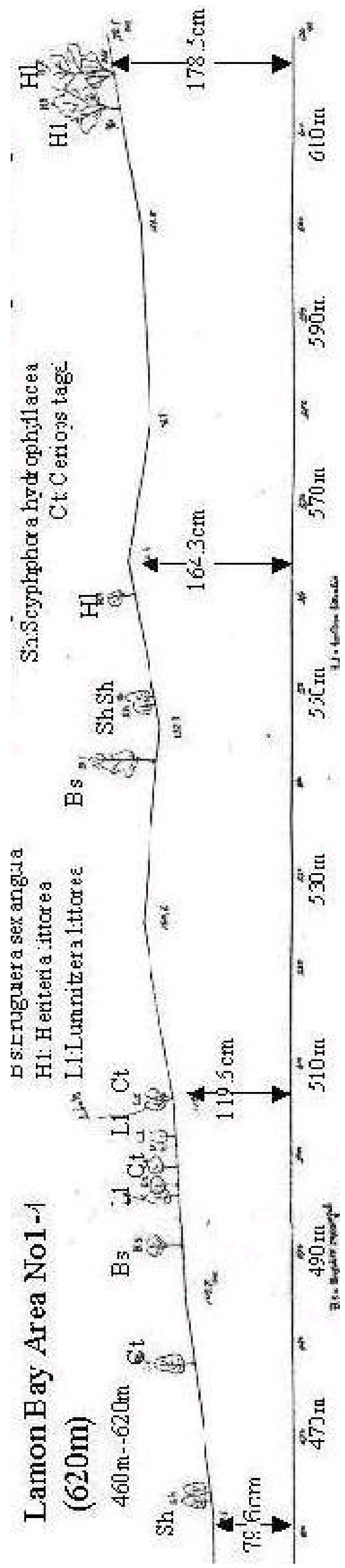


Fig. 2-2L-10 (4) Result of a Transect Survey in Lamon Bay Area (Binactocan)

Figures 2-2L-15(1) and (2) show the results of a transect survey in a comparatively narrow belt of mangroves at Binactocan in the Lamon Bay area. The location of this transect is marked (3) on Figure 2-2L-58. Along this transect line, there is a clearly-recognizable change in vegetation in response to changes in tide level. Short stands of *A. marina* and *S. caseclaris* appear along with *R. apiculata* on the outermost seaward fringe where the soil is slightly sandy.

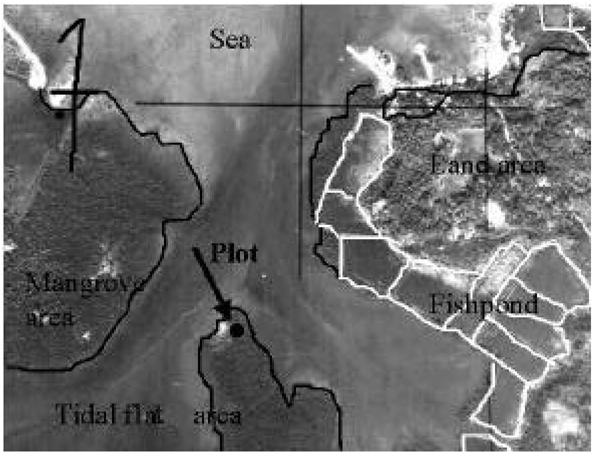


Fig. 2-2L-11 Survey Plot Location in Basiad Bay(Plot No 9:Comp. 507M8)

Table 2-2L-1 Stand Number by Species and Height (/ ha) (Plot No 9:Comp. 507 M8)

	Low	Mid	Tall	High	Total
Ra	2100	0	0	0	2100
Rm	200	0	0	0	200
Bg	150	0	0	0	150
Ct	50	0	0	0	50
Ao	0	0	0	0	0
Ll	0	0	0	0	0
Sh	0	0	0	0	0
Bs	0	0	0	0	0
Hl	0	0	0	0	0
0	0	0	0	0	0
Tot	2500	0	0	0	2500

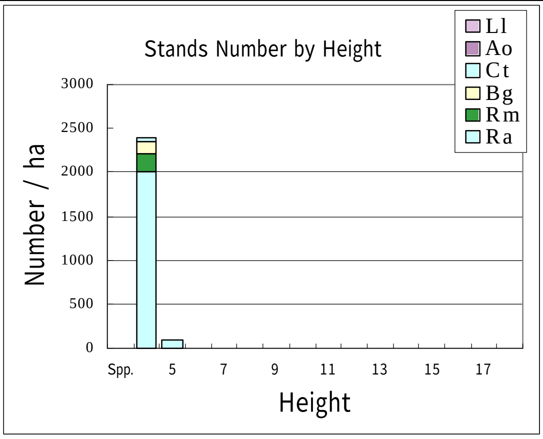


Fig. 2-2L-12 Stand Number by Species and Height (/ ha) (Plot No 9:Comp. 507M8)

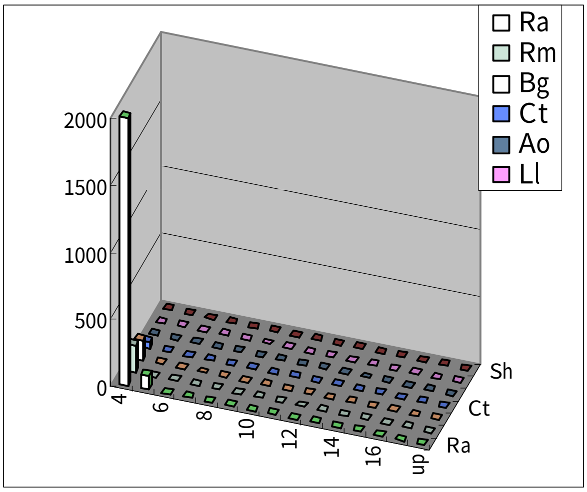


Fig. 2-2L-13 Stand Number by Species and Height (/ ha) (Plot No 9:Comp. 507M8)

Fig. 2-2L-14 Photograph of Survey Plot (R.a) (Plot No 9:Comp. 507M8)

Where the elevation increases to about 70 cm higher than the starting point of the line, there is an area dominated by *C. tagal* 4-6 meters tall. Where the elevation exceeds 100 cm above the starting point, the forest is dominated by *A. officinalis* with a mixture of *B. sexangula* and *B. parviflora*. As elevation increases, there is a corres-ponding increase in the height of *A. officinalis*. On the whole, however, the stands are rather thin. *S. hydrophyllacea* occupies the lower level of the canopy and *A. aureum* covers the forest floor.

The landward fringe is dominated by *H. littoralis* and terrestrial bushy stands that extend to the coconut groves on land. In this transect, *R. mucronata* trees are found rather close to the land. According to local residents, these trees were probably planted there in the past. Many of the *A. officinalis* have multiple and there are numerous old stumps. This indicates extensive cutting in the past and up to the present time, especially in the high inter-tidal area where the forest appearance is quite different from its original

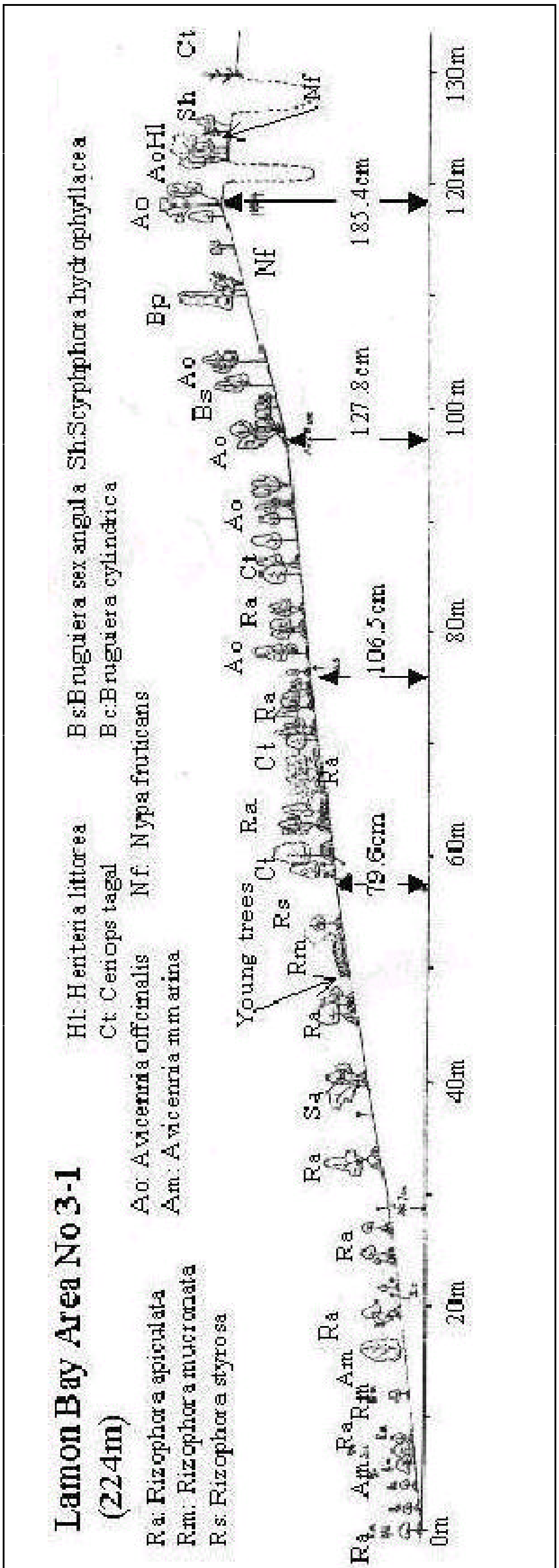


Fig. 2-2L-15(1) Transect Survey Result in Lamon Bay Area (Binactocan (2)) condition.

Figures 2-2L-19(1) and (2) also show changes in the mangrove forest from the outermost seaward edge moving inland in a narrow seaside area. This transect is located in mangrove about 200 meters wide, starting at a coral-rubble beach in the Basiad zone. The location of this transect is marked (3) on Figure 2-2L-58.

It is highly probably that large *S. alba* trees were once scattered on the outermost seaward fringe of the mangroves. At present, scattered growths of short *S. alba* trees are still found and several coppice have regenerated from large stumps. About 50 meters inward from the outermost *S. alba*, the vegetation changes to short stands of *R. apiculata* that form a community. Where the ground level elevation increases to about 60 cm above the starting point of the transect, *R. apiculata* is mixed with *B. gymnorrhiza* and *C. tagal*. Where the elevation further increases to around 100 cm, *A. officinalis* and *S. hydrophyllacea* appear.

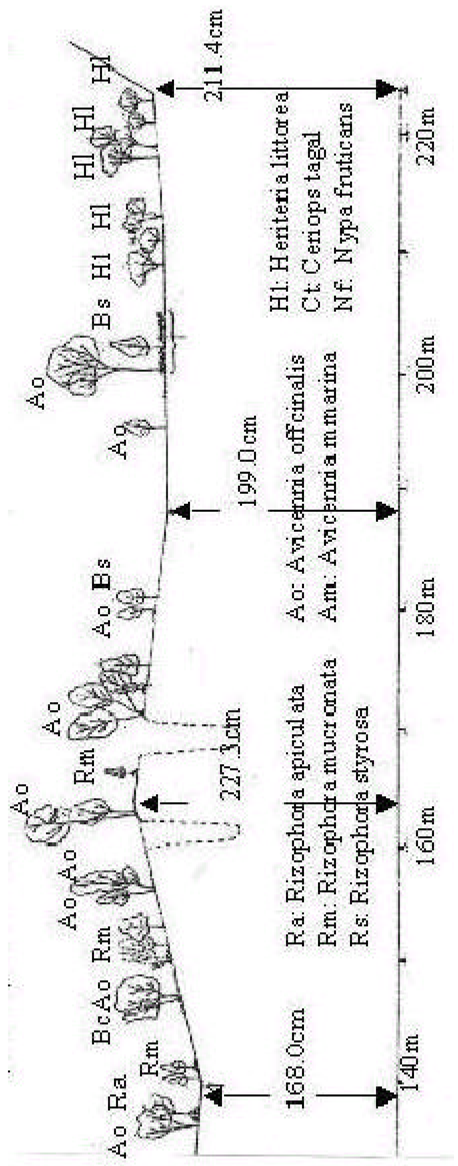


Fig. 2-2L-15(2) Transect Survey Result in Lamon Bay Area (Binactocan (2))

On this transect line, it is difficult to delineate horizontal zonation because water flowing along channels alters the normal flow of seawater with a consequent change in vegetation. For example, *C. tagal* and *B. parviflora* are usually found at middle inter-tidal area. However, on this transect line they even appear near the shore where the normal seawater flow is disrupted due to flow in the channels.

Mangrove forests on tidal flats in the Lamon Bay zone usually have short stands of *R. apiculata* at the seaward fringe, followed by stands of *R. apiculata* mixed with *B. gymnorrhiza* and *C. tagal* as one moves closer to the shore. A sample of these forests based on results of a plot survey are shown below. Figure 2-2L-16 identifies the location of the plot which is located about 250 meters heading inland from the seaward boundary. On the aerial photograph, trees in the plot that are adjacent to the *R. apiculata* growing on the outer seaward fringe are from 3 to 6 meters tall and look almost the same as the *Rhizophora*.

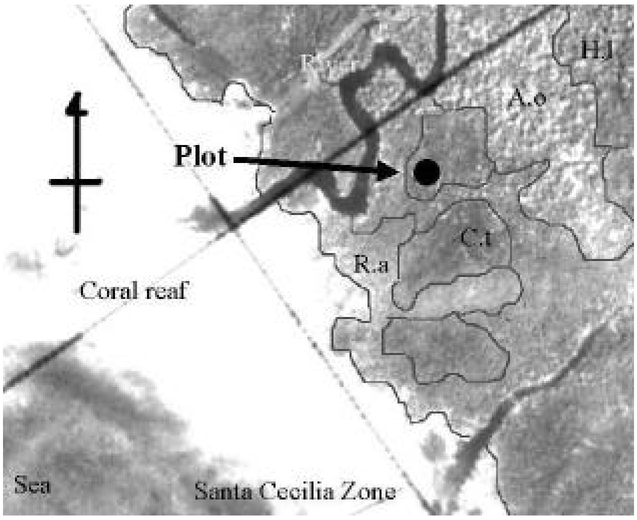


Fig. 2-2L-16 Survey Plot Location in Basiad Bay (Santa Cecilia) (Plot No 14:Comp. 203M20)

Table 2-2L-2 Stand Number by Species and Height (/ ha) (Plot No 14:Comp. 203M20)

	Low	Mid	Tall	High	Total
Ra	689	0	0	0	689
Rm	0	0	0	0	0
Bg	178	0	0	0	178
Ct	422	0	0	0	422
Ao	0	0	0	0	0
Xg	0	0	0	0	0
Am	0	0	0	0	0
Hl	0	0	0	0	0
	0	0	0	0	0
0	0	0	0	0	0
Tot	1289	0	0	0	1289

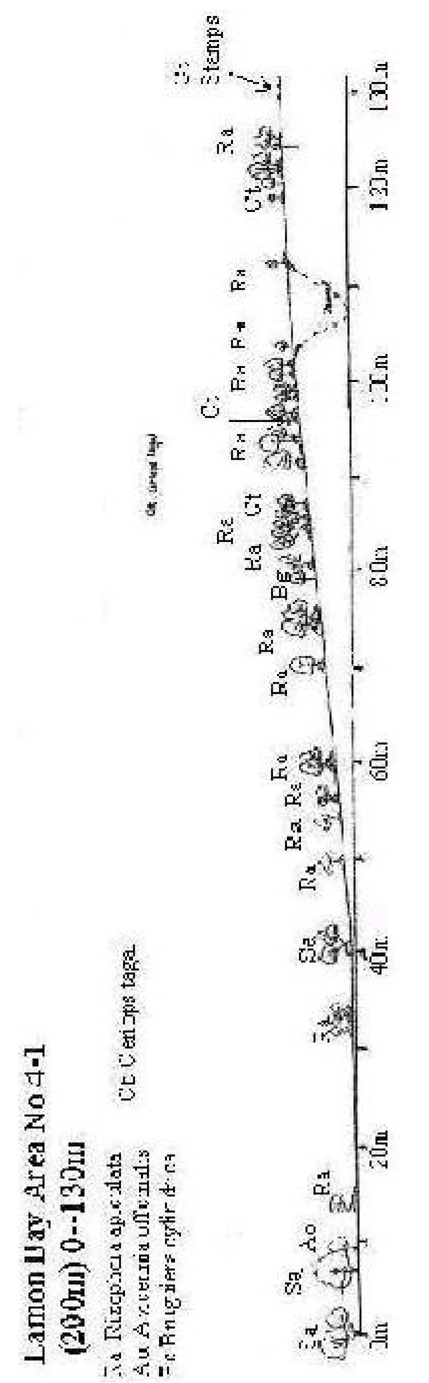


Fig. 2-2L-19(1) Transect Survey Result in Lamon Bay Area (Baciad)

A small, slightly-black crown can be seen on the aerial photograph. In reality, these trees are *C. tagal* and *R. apiculata* which form their respective dense communities, mixed with *B. gymnorrhiza*. Clusters of *C. tagal* are found at a slightly high elevation in relation to the outermost edge of the water at low tide. Overall, the crown density of these stands is not

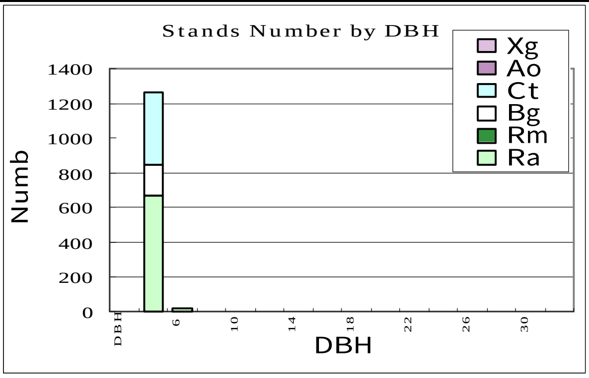


Fig. 2-2L-17 Stand Number by Species and Height (/ ha) (Plot No 14:Comp. 203M20)

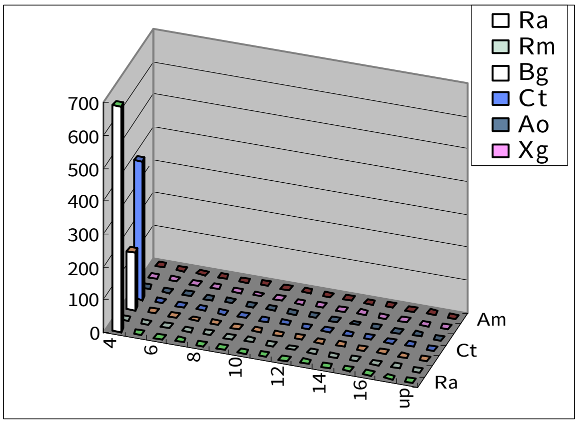


Fig. 2-2L-18 Stand Number by Species and Height (/ ha) (Plot No 12:Comp. 203M19)

particularly high since there are numerous open spaces, including water channels. Outside of the open spaces and water

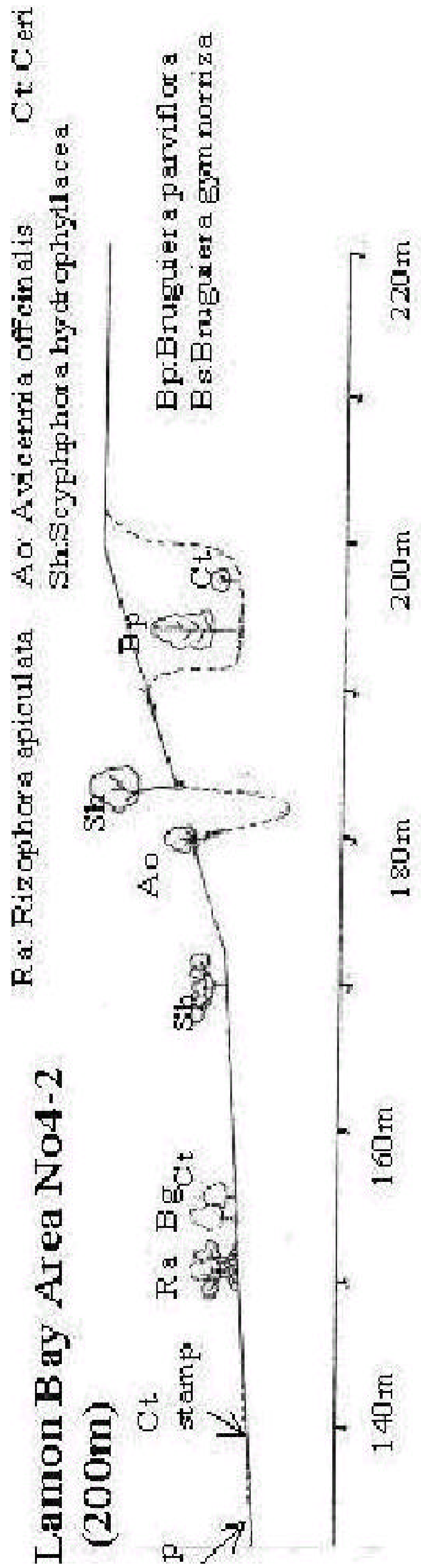


Fig. 2-2L-19(2) Transect Survey Result in Lamon Bay Area (Baciad) channels, the average crown density is no more than 60 to 70%. Small stumps found in the plot survey indicate on-going firewood gathering in this area. Table 2-2L-2 and Figures 2-2L-17 and 2-2L-18 present data on the stand structure in this plot.

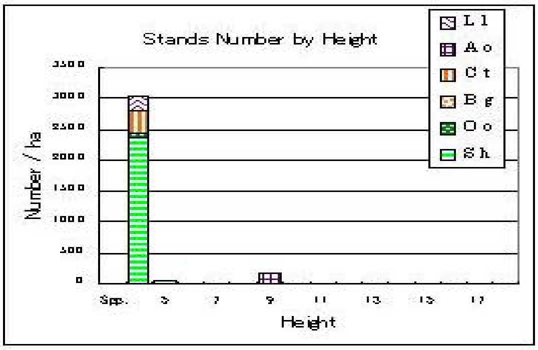


Fig. 2-2L-20 Stand Number by Species and Height (/ ha) (Plot No 12:Comp. 203M19)

Data on the Tables and Figures contain the results of a plot survey in an area where medium-diameter trees of *A. officinalis* grow in scattered pattern. The location of the plot is marked A.o on Figure 2-2L-16. The crown referred to above can be seen clearly on the aerial photograph where a slightly bright image reflects the white portion surrounding the crown.

Table 2-2L-3 Stand Number by Species and Height (/ ha) (Plot No 12:Comp. 203M19)

Spp.	Low	Mid	Tall	High	Total
Sh	2400	0	0	0	2400
Oo	100	0	0	0	100
Bg	0	0	0	0	0
Ct	350	0	0	0	350
Ao	0	150	0	0	150
Ll	250	0	0	0	250
	0	0	0	0	0
	0	0	0	0	0
Hl	0	0	0	0	0
0	0	0	0	0	0
Tot	3100	150	0	0	3250

Stands of *A. officinalis* in the upper layer are generally 7 to 10 meters tall but do not include large diameter trees. In the lower layer, *S. hydrophyllacea* comprise the major species, with the second most numerous being *C. tagal*, *L. littorea* and *Osbonia octodonta*. *Avicennia officinalis* constitute the upper canopy layer with an average population of 150 trees per ha. In the lower canopy, there are over 3,000 trees per ha.

Overall, these stands are almost closed-forests. The crown density of *A. officinalis* in the upper canopy is no more than 20%. This suggests that the most part of the original growth has been cut and removed. Table 2-2L-3 and Figures 2-2L-20 and 2-2L-21 show data on the stand structure in the survey

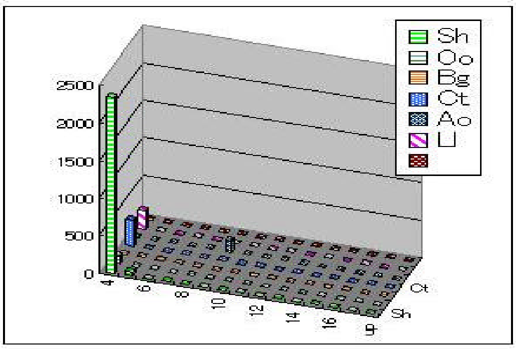


Fig. 2-2L-21 Stand Number by Species and Height (/ ha) (Plot No 12:Comp. 203M19) plot.

Figure 2-2L-22 shows the results of a transect survey on a line 130 meters long starting from the riverside and running at almost a right angle to the flow of a small river. This line is within the seaside area of the Lamon Bay zone. The ground elevation steeply rises near the river and the riverbank is about 100 cm above the surface of the water. The elevation of the forest floor is about 100 cm to 130 cm above the starting point and there are not abrupt changes in elevation. It is safe to assume that the entire forest floor at this elevation is normally above the high tide line and does not become submerged. This structure is fundamentally similar to the results of the survey in Aparri, but otherwise different given the absence of large rivers, less expanse of terrestrial vegetation, and the a lower density of nipa vegetation.

Due to small water channels and mud mounds that occupy the forest floor, it is difficult to identify a characteristic species composition on the aerial photographs. However, field verification reveals vegetation composed to 6-10 m short to medium-height trees of *A. officinalis* growing at the base of the mounds and short stands of *H. littoralis* growing on the mounds. These are partially mixed with *B. cylindrica* and *C. tagal* at the lower elevation of the transect line and *X.*

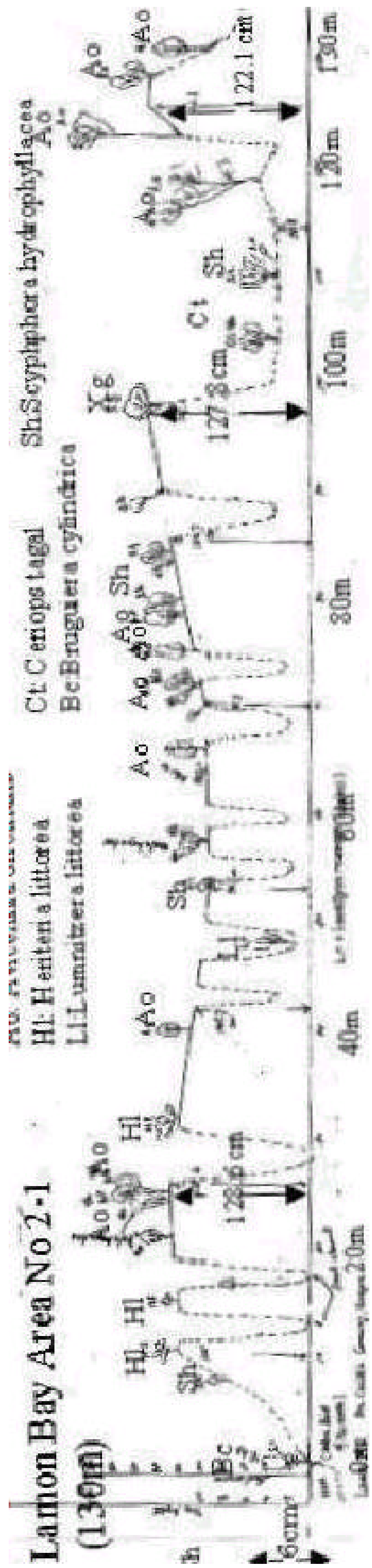


Fig. 2-2L-22 Transect Survey Result in Lamon Bay Area (Santa Cecilia) *granatum* and *S. hydrophyllacea* higher up. Although the stands grow taller as one moves toward the land, no significant change was found in the basic structure of forests along this 130 meter transect. The location of this transect is marked (4) on Figure 3-2-27.

The Lamon Bay zone has mangrove forests widely distributed over a big tidal flat, on the flat portions near small rivers flowing into the tidal flat, and flat areas found on both sides of a larger river where the flow is from very gradual to almost stationary. Forests characteristic of growth near the flat areas around small rivers extend along the coast of Santo Angel Bay and in the south eastern part of the bay in the Santo Angel Zone, the flat area surrounding the small river adjacent to the north eastern part of Santo Angel Bay, the Tiniguiban Zone, and the flat lands at the mouth of the Dapdap River.

The only fishponds in this zone are small in size and scattered. This is probably because this area is not accessible from the land and has a small population. Furthermore there are very few streams large enough to move produce in canoes. The largest mangrove area in the area is found in this zone. There are no abrupt changes in elevation along the forest floor except in small water channels where a 30-50 cm change may occur. Given these conditions, the environment is favorable for development of mixed-species mangrove stands and various patterns different from those found in the flat tidelands described earlier.

If they are slightly simplified and typified, they may be summarized as follows. Whereas stands of *R. apiculata* mixed with much *S. alba* and *S. caseolaris* are located in a sandy or coral rubble area facing the open sea, low stands of *R. apiculata* facing the sea are located in the muddy part of a tidal flat area in the bay.

Data on the plot of *S. alba* are shown in the following. The location of the plot is shown in Figure 2-2L-23. The plot is 4-7 m low stands located along the coast of Santo Angel Bay. *S. alba* is dominant and mixed with *R. apiculata*. These stands form a pioneer forest, extending overall along the coast and the crown density is as low as 60%. Data on the structure of stands in the plot are shown in Table 2-2L-4 and Figures 2-2L-24 and 2-2L-25.

Where the ground level slightly rises, there are a mixture of medium trees of *A. officinalis* and low tress of *A. lanata, B. gymnorrhiza* and *B. sexangula* or low stands of *C. tagal*, *B. parviflora*, *B. sexangula* and *B. cylindrica*

The next plot is one of two forest types extending to the *Sonneratia* forest and featured by much *C. tagal*.

The plot is located about 150 m landward from the seaside in the mouth of the Dapdap River as shown in Figure 2-2L-26. *R. apiculata* represents the majority of the forest with a mixture of *C. tagal* and *B. parviflora* and slightly mixing *B. gymnorrhiza*, *B. cylindrica* and *B. sexangula*. Although these stands are 4 to 8 m high, many trees are as low as under 6 m. They are found at a rate of over 5,000 trees per ha. The crown density exceeds 90%. Data on the structure of stands in the plot are shown in Table 2-2L-5 and Figures 2-2L-27 and 2-2L-28.

Table 2-2L-4 Stand Number by Species and Height(/ha)(Plot No 24 Comp. 302M1)

	Low	Mid	Tall	High	Total
Ra	156	0	0	0	156
Bg	0	0	0	0	0
Ao	0	0	0	0	0
Sa	333	0	0	0	333
Li	0	0	0	0	0
Sh	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0
Ll	0	0	0	0	0
Tot	489	0	0	0	489

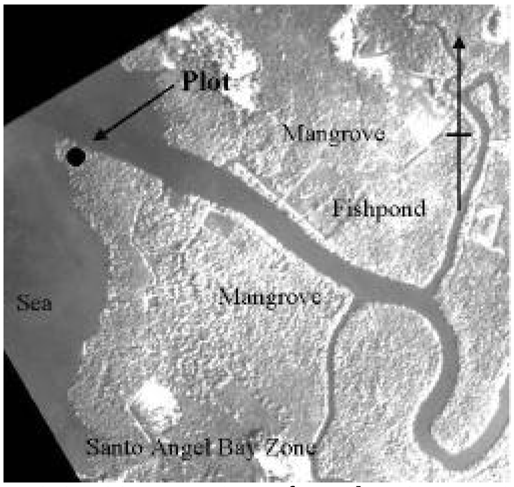


Fig. 2-2L-23. Location of a Plot Survey in Santo Angel Bay (Plot No 24 Comp. 302M1)

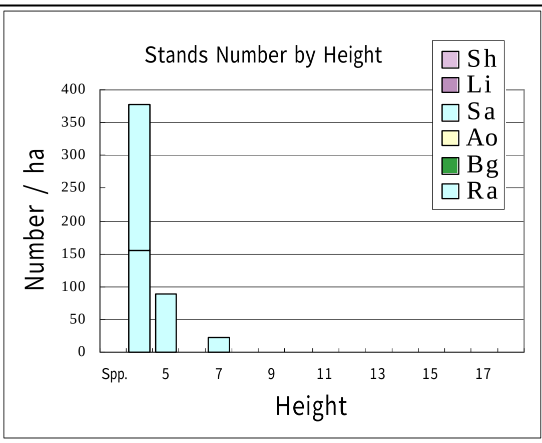


Fig. 2-2L-24 Stand Number by Species and Height (Plot No 24 Comp. 302M1)

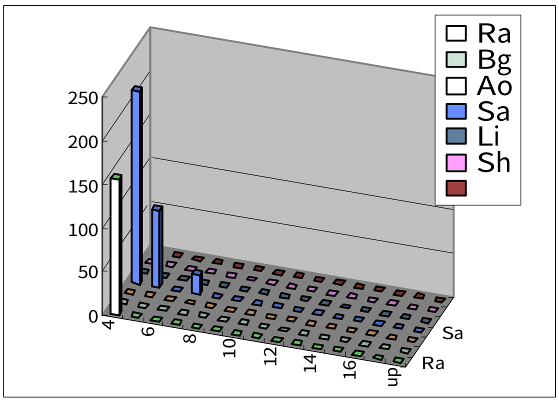


Fig. 2-2L-25 Stand Number by Species and Height (Plot No 24 Comp. 302M1)

Table 2-2L-5 Stand Number by Species and Height (/ha)(Plot No 15 Comp. 405M2)

	Low	Mid	Tall	High	Total
Ra	2650	0	0	0	2650
Rm	0	0	0	0	0
Bg	250	0	0	0	250
Ct	1200	0	0	0	1200
Bp	950	0	0	0	950
Bs	50	0	0	0	50
Bc	50	0	0	0	50
Oo	0	0	0	0	0
Hl	0	0	0	0	0
0	0	0	0	0	0
Tot	5150	0	0	0	5150

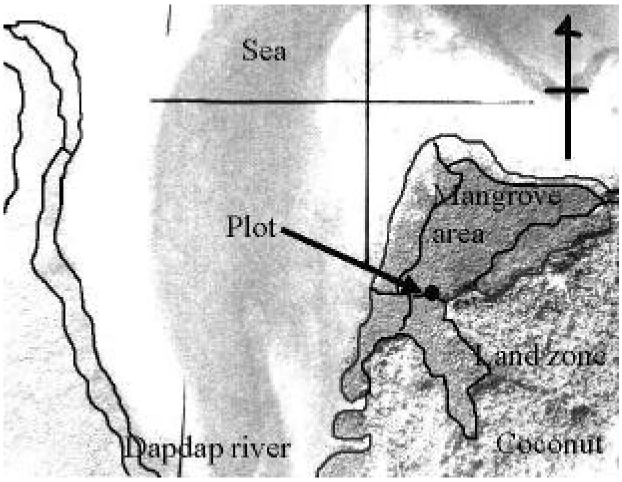


Fig. 2-2L-26 Location of a Plot Survey in Dapdap River(Plot No 15 Comp.405M2)

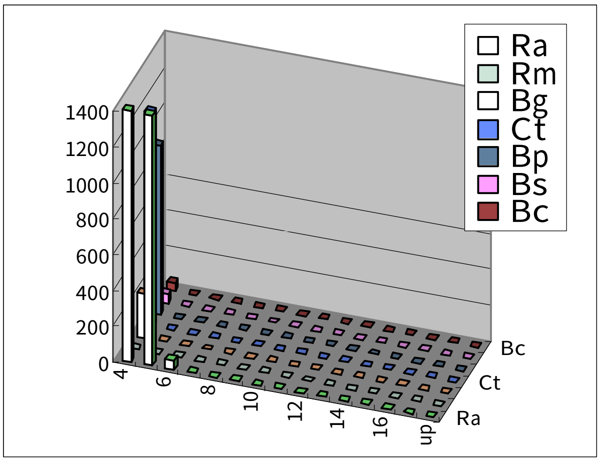


Fig. 2-2L-28 Stand Number by Species and Height (/ha) (Plot No 15 Comp.405M2)

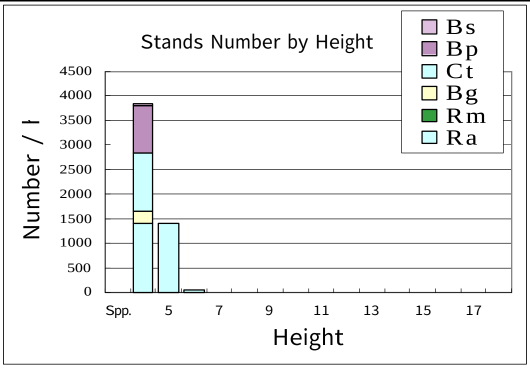


Fig. 2-2L-27 Stand Number by Species and Height (/ha) (Plot No 15 Comp.405M2)

The next plot is a sample of forests dominated by *A. officinalis* as another forest type, which usually appears after *R. apiculata* forests. The plot is located about 80 m landward from the east-coast of Santo Angel Bay as shown in Figure 2-2L-29. The upper layer is occupied by 9-12 m *A. officinalis* stands with a crown density of 75%, while the mid and lower layers are densely occupied by 4-8 m *B. parviflora* and *B. cylindrica* stands, under which young trees of *X. granatum*, *C. tagal* and *S. alba* are mixed. There are large stumps seemingly of *S. alba* left in the plot, which suggests that this plot was a sandy coast in the old days. Data on the structure of stands in the plot are shown in Table 2-2L-6 and Figures 2-2L-30 and 2-2L-31.

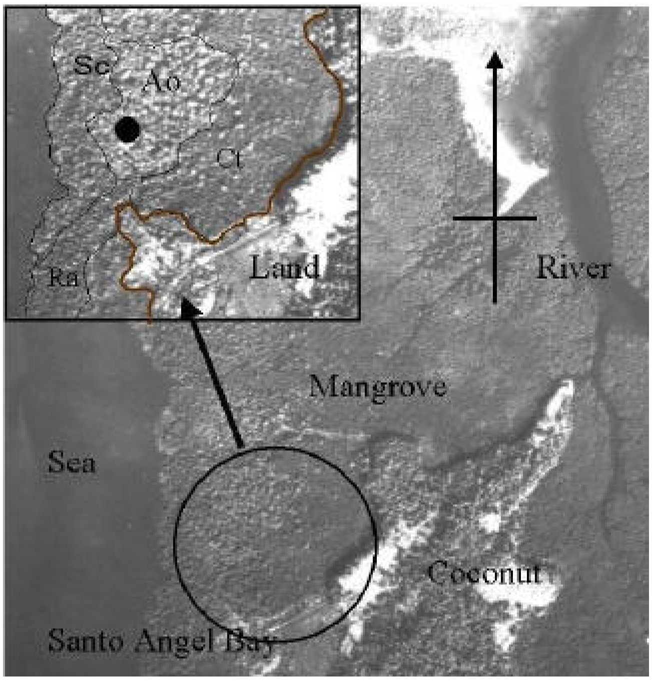


Fig. 2-2L-29 Location of a Plot Survey in Santo Angel Bay(Plot No 17,Comp.306M13)

Table 2-2L-6 Stand Number by Species and Height (/ha)(Plot No 17,Comp.306M13)

	Low	Mid	Tall	High	Total
Sa	44	0	0	0	44
Ao	267	133	22	0	422
Xg	200	0	0	0	200
Ct	111	0	0	0	111
Bc	289	0	0	0	289
Bp	1133	0	0	0	1133
	0	0	0	0	0
Hl	0	0	0	0	0
	0	0	0	0	0
0	0	0	0	0	0
Tot	2044	133	22	0	2200

The ground level rises more. In middle and high intertidal areas, a maze of small channels and a mud mound make a complicated pattern on the forest floor. *A.*

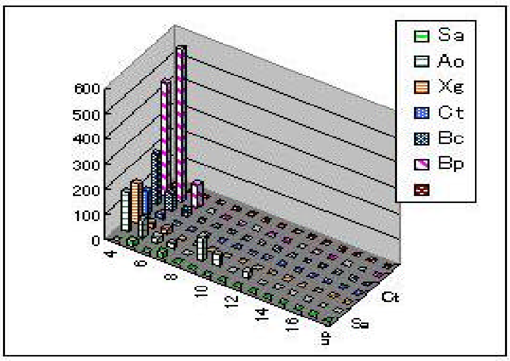


Fig. 2-2L-31 Stand Number by Species and Height (/ha) (Plot No 17,Comp.306M13)

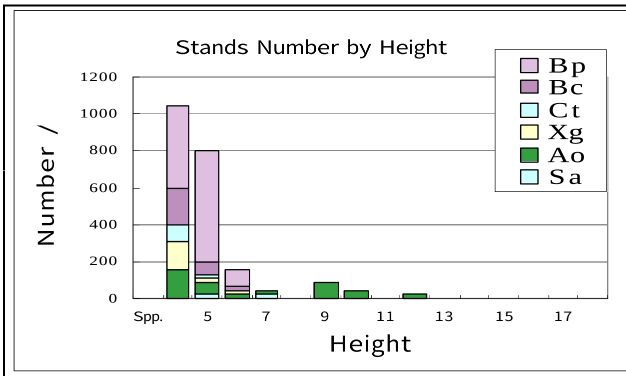


Fig. 2-2L-30 Stand Number by Species and Height (/ha) (Plot No 17,Comp.306M13) *officinalis* and *S. hydrophyllacea* grow along these channels, and *X. granatum* and *H. littoralis* grow on the mound. Low mixed stands of *C. tagal, B. sexangula* and *B. gymnorrhiza* appear in a slightly expanded lower part in the interspace. A small and slightly black colored crown of *A. officinalis* can be observed on the aerial photograph. A sample plot of these mangrove forests near the land area is shown in the following.

Fig. 2-2L-32 Photograph of the Survey Plot (Ao) (Plot No 17,Comp.306M13)

The location of the plot is shown in Figure 2-2L-36. The plot is located on the east-coast near Tinagung Dapat Bay in the Basiad Zone. It is on the edge of a small hill about 200 m landward from the coast line and near the high intertidal zone. It is presumable that large trees of *A. officinalis* were cut in order to develop fishponds in the old days. In fact, many trees of *A. officinalis* have stems growing from the same roots. *A. officinalis* trees about 8 m high are dominant in the middle layer. Many trees of *S. hydrophyllacea* grow under them. Data on the structure of stands in the plot are shown in Table 2-2L-7 and Figures 2-2L-34 and 2-2L-35.

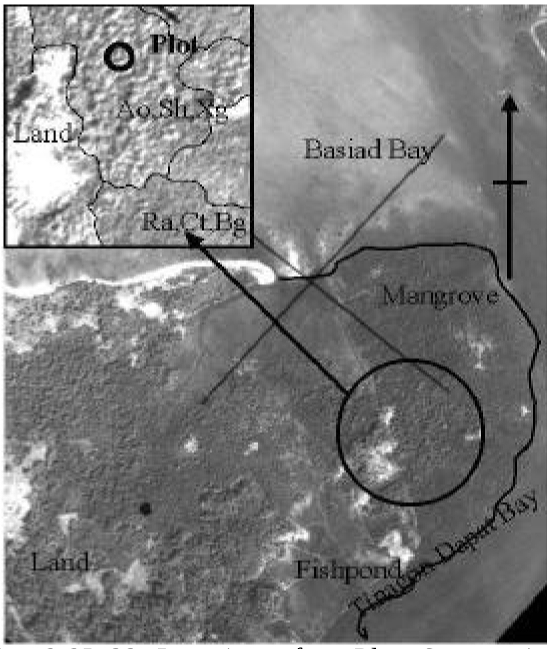


Fig. 2-2L-33 Location of a Plot Survey in Basiad Bay(Plot No 6 Comp.520M5)

Table 2-2L-7 Stand Number by Species and Height (/ha)(Plot No 6 Comp. 520M5)

	Low	Mid	Tall	High	Total
Ra	0	0	0	0	0
Rm	0	0	0	0	0
Bg	44	0	0	0	44
Ct	133	0	0	0	133
Ao	867	22	0	0	889
Xg	178	0	0	0	178
Sh	400	0	0	0	400
Bs	22	0	0	0	22
Hl	22	0	0	0	22
0	0	0	0	0	0
Tot	1667	22	0	0	1689

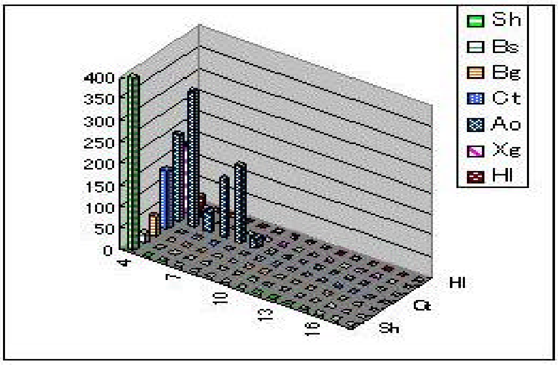


Fig. 2-2L-35 Stand Number by Species and Height (/ha) (Plot No 6 Comp.520M5)

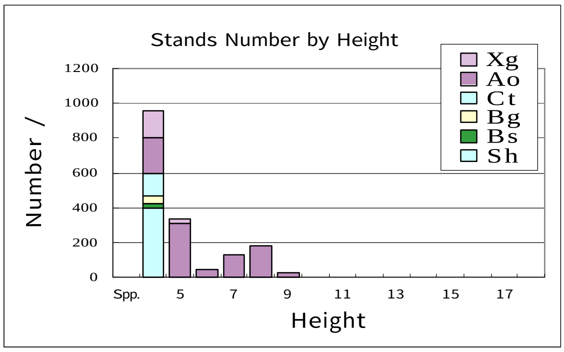


Fig. 2-2L-34 Stand Number by Species and Height (/ha) (Plot No 6 Comp.520M5)

The most part of the mangrove forest nearest the land area seems to be affected by human beings in one way or another. Because the upper layer has generally disappeared, only medium trees of *H. littoralis* are dotted and low mangrove trees grow along with bushes and climers under them. This is an area which looks like a low forest area with small and relatively bright crowns dotted in the aerial photograph.

The next sample plot is a bushy area adjoining the land area. The plot is located in the southeastern part of the Tiniguiban Zone on the west coast of Basiad Bay. *H. littoralis* does not appear probably because of proximity to the land area. *E. agallocha* is the only mangrove species slightly found in the plot. The crown density is no more than 15% in the lower layer. Although the DBH of this species as well as *A. officinalis* and *X. granatum* on record exceeds 40 cm, the height is no more than 7 m. Trees of *E. agallocha* seem to have

Table 2-2L-8 Stand Number by Species and Height (/ha) (Plot No 27, Comp. 408M9)

	Low	Mid	Tall	High	Total
Ra	0	0	0	0	0
Rm	0	0	0	0	0
Bg	0	0	0	0	0
Ct	0	0	0	0	0
Ao	50	0	0	0	50
Xg	50	0	0	0	50
Ea	250	0	0	0	250
Hl	0	0	0	0	0
	0	0	0	0	0
0	0	0	0	0	0
Tot	350	0	0	0	350

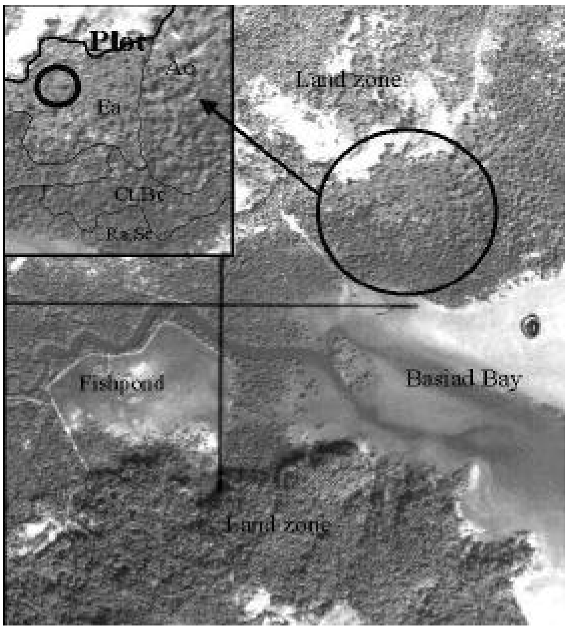


Fig. 2-2L-36 Location of a Plot Survey in Tiniguiban(Plot No 27, Comp. 408M9) regenerated by coppice from stumps after being cut. Since there are also stumps of *A. officinalis* left in the plot, it is imaginable that the plot was once a mangrove forest similar to the fore-mentioned plot. *A. aureum* and *A. ilicifolius* grow well in a part of the forest floor not covered by bushes. The location of the plot is shown in Figure 2-2L-36 and the structure of stands is shown in Table 2-2L-8 Figure 2-2L-37 and Figure 2-2L-38.

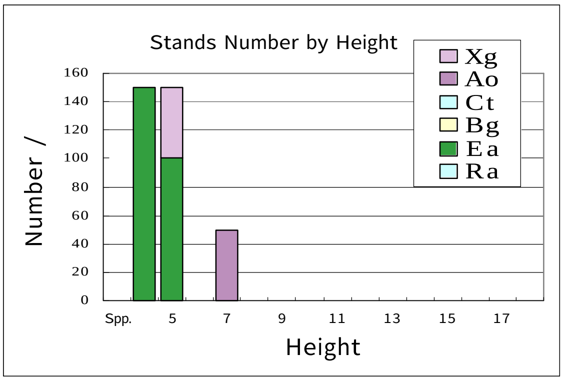


Fig. 2-2L-37 Stand Number by Species and Height (Plot No 27, Comp. 408M9)

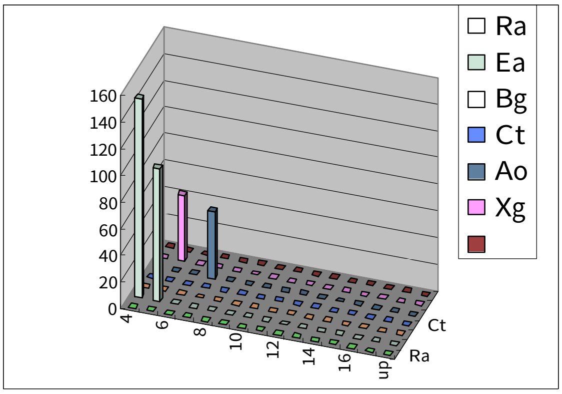


Fig.2-2L-38 Stand Number by Species and Height (Plot No 27, Comp. 408M9)

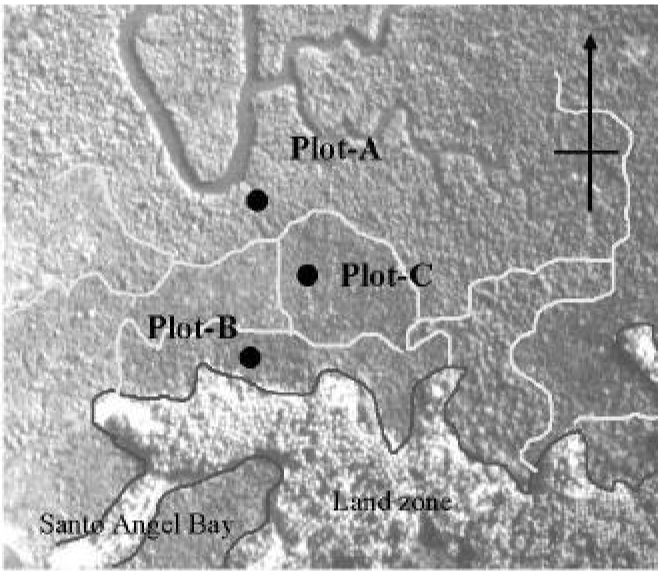


Fig. 2-2L-39 Location of a Plot Survey in Santo Angel Bay

Mangrove forests occupy a large part of the Lamon Bay area, including a large tidal flat and areas along small rivers flowing into the flat. Small streams complicatedly run in all directions in this area and affect to the flow of seawater at high and low tide. It is difficult to estimate changes in tide level based on distances from the sea or small rivers in the aerial photograph. As previously stated several times, a difference of about 40 cm in the ground level has a great effect on the composition of mangrove species. In addition to this, the flow of fresh water from rivers is also complicated. That is why mangrove species which usually appear at low inter-tidal area are found near the land area in this plot. Accordingly, mangrove forests in the plot are difficult to classify in view of vegetative characteristics.