5.2.3 Presence and abundance of the plant species

At 62 stations, the vegetation of the right and left bank was recorded during the study. Therefore, a total of 124 vegetation transects was investigated. In the following paragraphs the vegetation is regarded first on a population level and afterwards on a plant communities level.

Plant	**Absolut presence**	**Relative presence**	**Relative presence within the 15 most present species**	**Relative presence above abundance's sum**	**Absolute dominace (aD)**
Rhizophora racemosa	116	93,5%	21,7%	16,7%	54,26
Zygia cataractae	54	43,5%	10,1%	7,8%	7,98
Machaerium lunatum	51	41,1%	9,6%	7,3%	7,13
Pachira aquatica	44	35,5%	8,2%	6,3%	3,63
Montrichardia arborescens	41	33,1%	7,7%	5,9%	0,63
Acrostichum aureum	39	31,5%	7,3%	5,6%	1,11
Dalbergia monetaria	39	31,5%	7,3%	5,6%	3,02
Rhabdadenia biflora	39	31,5%	7,3%	5,6%	0,59
Laguncularia racemosa	24	19,4%	4,5%	3,4%	1,63
Clytostoma binatum	17	13,7%	3,2%	2,4%	0,32
Crinum erubescens	16	12,9%	3,0%	2,3%	0,46
Hippocratea volubilis	16	12,9%	3,0%	2,3%	0,47
Pterocarpus officinalis	14	11,3%	2,6%	2,0%	0,74
Rhizophora mangle	14	11,3%	2,6%	2,0%	1,96
Pavonia paludicola	10	8,1%	1,9%	1,4%	0,06
total	534	431%	100%	77%	84,01

Tab. 9: Absolute and relative presence of the 15 most common plants

In total, 77 terrestrial plant species were recorded. A complete list with these plants can be found in the Appendix 7.1. Once, a tuff (diameter about one meter) of floating *Eichhornia crassipes* was seen. As it was right at the transect Va6R, it was noted in the record sheet, but in the following analysis only the terrestrial plants appear. Tab. 9 shows the 15 most common plants of the bank vegetation with their absolute and relative presence and their absolute dominance, but only 19,5 % of the 77 species found in the study area are represented. 31 plants occured only one time (40,3 %) and 31 plants (40,3 %) were found only two to nine times in the study area. The percentage of the "relative presence above the abundance's sum" is calculated with the sum of the absolute presence of all species ($\sum$ absolute presence of all species = 696), while the "relative presence of the 15 most present species" uses the absolute presence of the in the table represented species.

The maximum of the absolute dominance (*aD*) is for the present study with 124 samples and with abundance classes from 0,1 to 75 at 88,068, the minimum is close to zero ($9,4\overline{69}e^{-4}$).

In chapter 5.1.1 the classification according to abundance and dominance is explained. The groups presented in the study are the following:

1. plants constantly present with high dominance (cf. Fig. 29),
2. plants frequently present with medium dominance (cf. Fig. 30),
3. plants rarely present with low dominance (cf. Fig. 31),
4. plants rarely present without dominance and (cf. Fig. 32),
5. plants sporadically present without dominance (cf. Fig. 33).

The chosen species are typical representatives of the sampled vegetation.

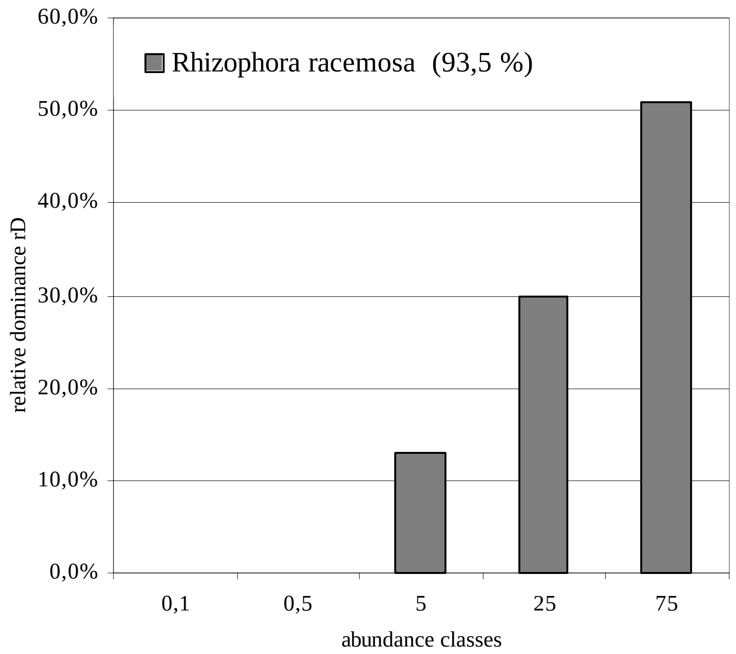


Fig. 29: Plant constantly present, with high dominance

Group 1:

Rhizophora racemosa was the most common plant and appeared 116 times in the whole area (93,5 %). All others plants were less abundant and were only represented at less than half of all stations. The analysis of the absolute dominance showed the same result, as *R. racemosa* has a dominance value far higher than all other plants (*aD* = 54,26).

When present, *R. racemosa* had at least an abundance of class 5 (cD_5 = 13,8 %), but normally it was very dominant (cD_{75} = 54,3 %). 29,8 % of the samples were grouped in the abundance class 25.

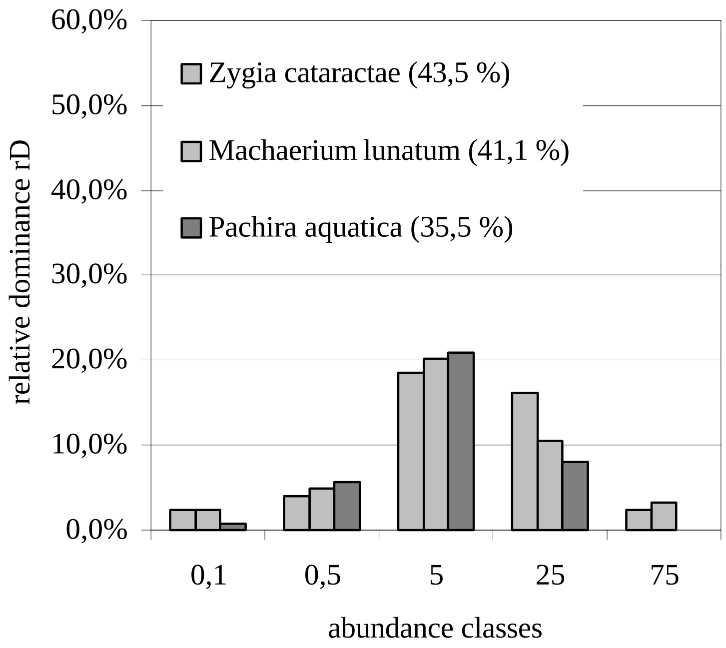


Fig. 30: Plants frequently present with medium dominance

Group 2:

Zygia cataractae, *Machaerium lunatum* and *Pachira aquatica* belong to the frequently occurring plants. Their relative presence *rP* was between 35,5 % and 43,5 % and therefore they wereplaced into the group of "frequently" present plants. Their dominance was medium, as they did not reach the 50 % - limit for the relative dominance rD_{xx}, but all plants were represented at least in one abundance class with more than 5 %. Concerning the absolute dominance *aD*, these three plants followed *R. racemosa* in the ranking of *aD*. *Z. cataractae* and *M. lunatum* are the two only species represented in all abundance classes, with a peak at cD_5 = 42,6 % for *Z. cataractae* and cD_5 = 49,0 % for *M. lunatum*. *P. aquatic* reached the maximum value of all plants with a rD_5 = 21,0 %.

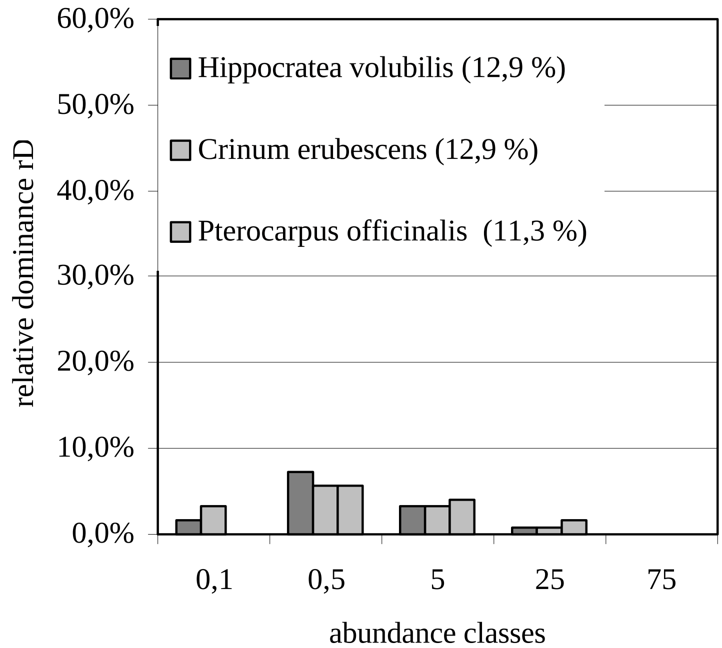


Fig. 31: Plants rarely present with low dominance

Group 3:

The next group is composed of plants with rare presence and low dominance. *Hippocratea volubilis*, *Crinum erubescens* and *Pterocarpus officinalis* belong to this group. They were characterised by an *rP* between 2,5 % and 25 % and a dominance of 5 % to 25 %. The three represented species showed this later mentioned dominance in the abundance group 0,5. Their absolute dominance was by far lower than in the previous group (between 7,981 and 0,588 / median 3,021; here: 1,634 – 0,063 / median 0,467).

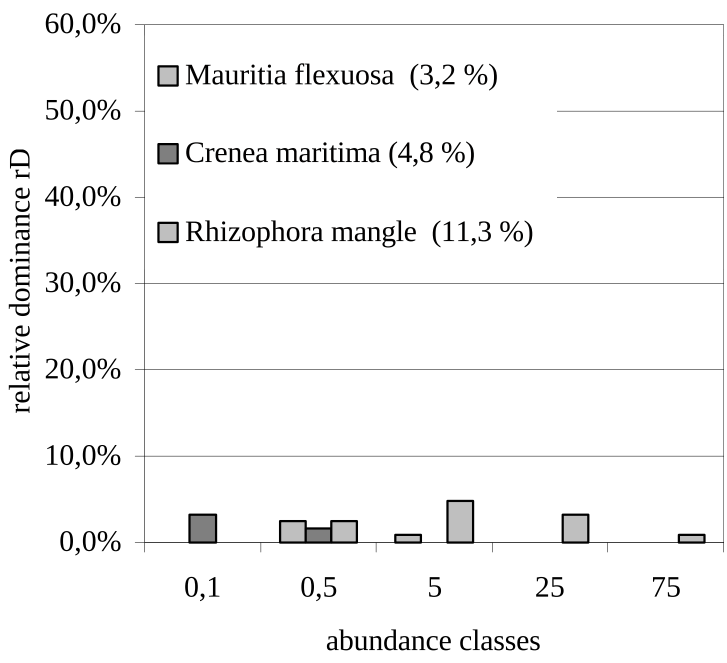


Fig. 32: Plants rarely present without dominance

Group 4:

Plants with rare presence and without dominance are represented in the second largest section with 21 species. In this group *Mauritia flexuosa*, a palm tree, which is characteristic for the banks of small temporary creeks in savannahs (GRANVILLE 1986) and *Crenea maritima*, a small herbaceous plant restricted to tidal flats (TOMLINSON 1986) had a low *rP*. Both only occured in the abundance classes 0,1 and 0,5. In contrast, *Rhizophora mangle* was only recorded with abundance values exceeding class 0,1. Nevertheless, it is also put into in this group, as its *rP* = 11,3 % and the rD_{max} = 4,8 % was between the fixed limits for the groups. Because of the accumulated occurrence in the upper abundance classes *R. mangle* has an *aD* = 1,955, the fifth highest values for all plants.

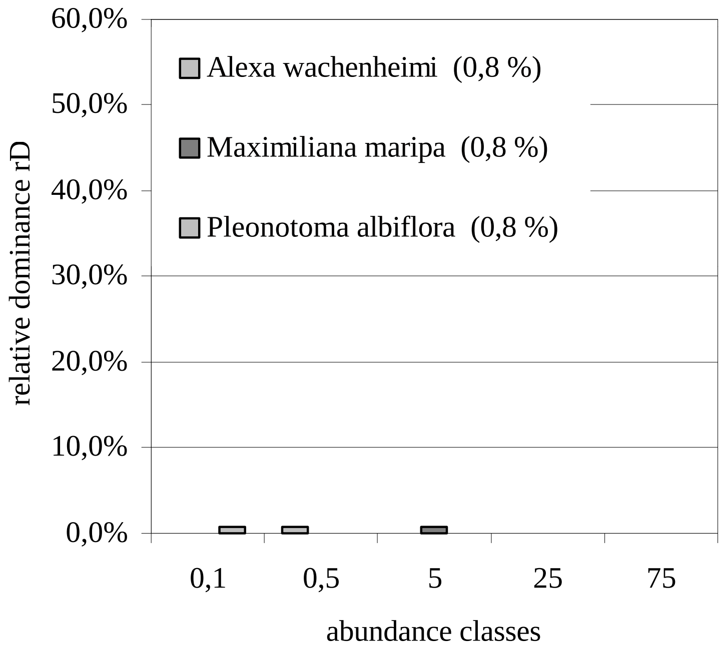


Fig. 33: Plants sporadically present and without dominance

Group 5:

The last and largest group by species number is formed by 42 plants never becoming dominant and with only sporadic presence. The chosen examples all had a cD_{xx} = 100 %, as they were only found one time in the study area. Their *aD* was very low (*A. wachenheimi* 0,005, *M. maripa* 0,047, *P. albiflora* 0,001). The median for the whole group was at 0,008.

5.2.4 Vegetation classification of all samples

After the analysis of vegetation on a plant species level, the following paragraphs discuss vegetation on a community level. For a first approach, all samples were taken into account, while later only the combined samples were regarded. In both cases, the results of the cluster analysis were accumulated to eight or four groups described below. When percentages or average values are given, the median is used for all samples. Their distribution in the study area can be seen on the Maps 13 and 14.

As already mentioned in chapter 5.1.1, the classification presented here has not the pretension to be a syntaxonomic classification in the strict sense of Tüxen and Braun-Blanquet.

The 124 samples can be divided in two groups (A and B) by the presence/absence of *Rhizophora racemosa*. In 19 cases *R. racemosa* was not dominant (group A), while in group B the species was constantly present and had as least an abundance of 5.

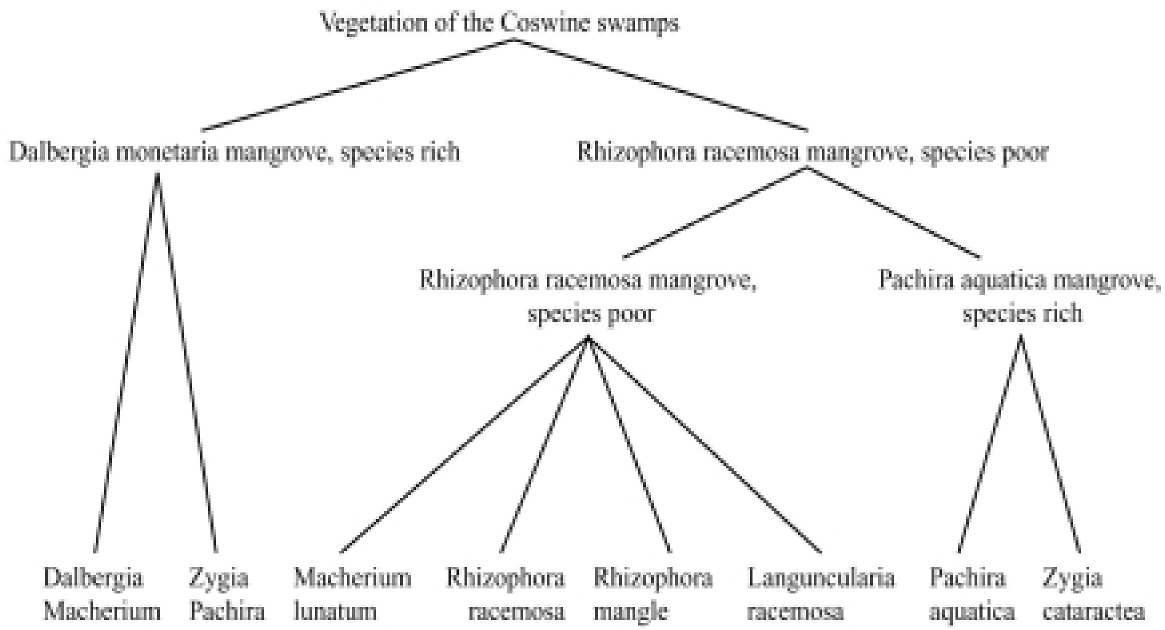


Fig. 34: Hierarchical diagram of the vegetation units

Group A – *Dalbergia monetaria* mangrove, species rich

In this group with 19 samples, *Rhizophora racemosa* was not present (7 times) or in abundance class 5 (11 times). In one sample (Va1R), *R. racemosa* had an abundance of 25. At the same time, the number of species per samples was high with a median of 9,0 plants for each transect. The *S/S* reached with 1,410 the highest value of all investigated groups. The evenness was high as well (E = 43 %) and the index of diversity at 1,877. Except for the sample Va1R, *R. racemosa* was not the dominant species. The cluster analysis divided the group A into two units: unit 1 with a dominance of *Zygia cataractae* and *Pachira aquatica* and unit 2 with mainly *Machaerium lunatum* and *Dalbergia monetaria*. Besides these dominate plants especially *Montrichardia arborescens* often appeared in this group.

Unit 1 –*Zygia cataractae* and *Pachira aquatica* mangrove

This formation, composed of eleven samples, is characterised by the dominance of *Zygia cataractae* which reached the abundance class 75 in one sample. Only in one transect, *Z. cataractae* had an abundance lower than 5, in this single case *Rhizophora mangle* was abundant with class 25. *Pachira aquatica* is the second most important species and constantly present with at least an abundance of 5. The species number per transect was high (10 species) just as the number of occurring plants in all samples (43, what means 55,8 % of all species). The indecies of diversity and evenness (45 % and 1,490) had high values and the *S/S* (1,144) reached the highest values of all eight units. This unit of *Zygia cataractae* and *Pachira aquatica* can therefore be described as the species richest formation in the Coswine swamps. Besides the already mentioned plants, some other species were well represented: *Dalbergia monetaria* once even reached the abundance class 25 and did not occur in only three samples. Further *Pterocarpus officinalis* was present in 63,6 % of all samples. *Euterpe oleracea* is worth mentioning as a species sometimes present (27,3 %), but only in abundance classes 5 and 25. *Virola surinamensis* was a little more frequent, but its abundance was lower (0,1 – 5). *Montrichardia arborescens* showed the same abundance, but was only in 72,7 % cases present.

Unit 2 –*Machaerium lunatum* and *Dalbergia monetaria* mangrove

A relative small group of only eight samples was formed by the dominate *Machaerium lunatum* and *Dalbergia monetaria*. These two species were accompanied by the liana *Rhabdadenia biflora* which was present in seven of the eight transects in low abundance (0,1 – 5) and *Clytostoma binatum* (4 times, abundance 0,5 - 5). *Desmonchus polycanthus*, a thorny palm species, is a further plant which was often found (50 %) in middle abundance (5 and 25). Species number (7,5), index of diversity (1,770) and evenness (41 %) were lower than in the previous unit. In contrast, the *S/S* of 0,456 indicates that this unit had a lesser species diversity than the previous one. An exception is the sample Ca7L, where 17 species were represented. With *Languncularie racemosa* another typical mangrove plant occurred. It was found in 50 % of all samples in abundance between 0,5 and 25. When the plant was present, *Rhizophora racemosa* normally was not found. Again *Montrichardia arborescens* was well present (50 %), but in low abundance (0,5 – 5).

Group B – *Rhizophora racemosa* mangrove, species poor

In this group, widely dominated by the Red Mangrove which in only 5,7 % of the samples had an abundance lower than 25, six units were obtained by the cluster analysis. These can be regrouped into two subgroups by the quantity of the appearing species. In total, 105 samples were regarded and 61 species occurred in this group. Therfore, the *S/S* was - 0,092, one of the lowest values of the whole study. In contrast to group A, evenness (17 %) and diversity (H = 0,551) were much lower.

Subgroup I - *Rhizophora racemosa* mangrove, species poor

For the first subgroup, species richness (3 different plants in each transect), index of diversity (0,551) and evenness (13 %) were low. Furthermore, the *S/S* had the lowest value (– 0,482) obtained for all groups, as the number of species was low as well (34). The small values for evenness in connection with the low number of species indicated that these formations were more or less "monocultures" of *R. racemosa*. In fact, in only four of the 74 samples (5,4 %) dominance of the species was not clearly visible, as the abundance class 75 was not present and at the same time, two plants with abundance class 25 occurred.

Unit 3 –*Rhizophora racemosa* mangrove

R. racemosa widely dominated in this unit with 42 samples. In total, only 23 species were found. In only five transects, *R. racemosa* had an abundance lower than 25 (9,5 %). In eleven samples only *R. racemosa* occurred. (24,4 %). A sub-unit with *Acrostichum aureum* can be distinguished in 21 cases (46,6 %). In general, the abundance of *A. aureum* was low (0,1 – 5), except for two samples where class 25 was reached. Therefore the index of diversity was very low (H = 0,328) and the distribution very uneven (8 %). With – 0,106 the *S/S* had the lowest value for all units. This is also the case for the diversity index and the evenness. Other plants, which occasionally occurred, are *Zygia cataractae* (abundance 0,1 – 5) and *Kyllinga brevifolia* (16,7 % of the 42 samples, abundance 0,1 – 0,5), *Crenea maritima* (0,1 – 0,5) and *Pachira aquatica* (0,1 – 0,5 / 14,3 %) and *Rhabdadenia biflora* (0,1 – 5 / 11,9 %).

Unit 4 –*Machaerium lunatum* mangrove

Evenness and the diversity index were slightly higher in the second formation (E = 17 %, H = 0,744), even when the median number of species (3) was not any bigger. The *S/S* was also higher (0,125). *Machaerium lunatum* joined *R. racemosa* as a species with high abundance (5 – 75). In seven out of the total of 15 samples (46,7 %), *Zygia cataractae* formed a sub-unit with an abundance between 5 and 25. Two other plants occurred in a small part of the samples (18,8 %) and in low abundance (0,1 – 0,5): *Rhabdadenia biflora* and *Montrichardia arborescens.*

Unit 5 –*Rhizophora mangle* mangrove

A relatively small sample size was yielded for the third unit, as only 8 transects form this group. *R. mangle* constantly reached an abundance class of 5 or higher, but *R. racemosa* was still present as well (abundance 25 – 75) except for one sample (Va1L), where *R. mangle* was dominant with an abundance of 75 and *R. racemosa* did not occurred. *Machaerium lunatum* may be used to describe a sub-unit, but the sample size was too small to test that assumption. It was present in 50 % of the samples in medium dominance (0,5 – 25). *Zygia cataractae* was also well present (37,5 %) but only in low abundance

(0,1 – 5). Concerning evenness, diversity and the *S/S*, the *R. mangle* mangrove is comparable to the previous one (E = 20 %, H = 0,885, *S/S* = 0,138).

Unit 6 –*Languncularia racemosa* mangrove

The last unit of the first subgroup is characterised by the appearance of *L. racemosa*, accompanied by *Rhabdadenia biflora*. In this alliance the level of 1 was exceeded for the diversity index (1,064) for the first time. Evenness reached to 24 % and the median of occurring species in the transects was 4. Therefore this unit can be described as a linking unit to the following subgroup. *S/S* (0,161) was the highest for all units low in species. *Machaerium lunatum* once again may be used to determine a sub-unit, but like in unit 3, the number of samples was low (8). *M. lunatum* was present in half of them with little dominance only (5 – 15). Except for one sample, *R. racemosa* was dominant with an abundance of 75. Only in the sample Mn1R *R. racemosa* had a lower abundance. There *L. racemosa* and *M. lunatum* were strong competitors (abundance of 25).

Subgroup II – *Pachira aquatica* mangrove, species rich

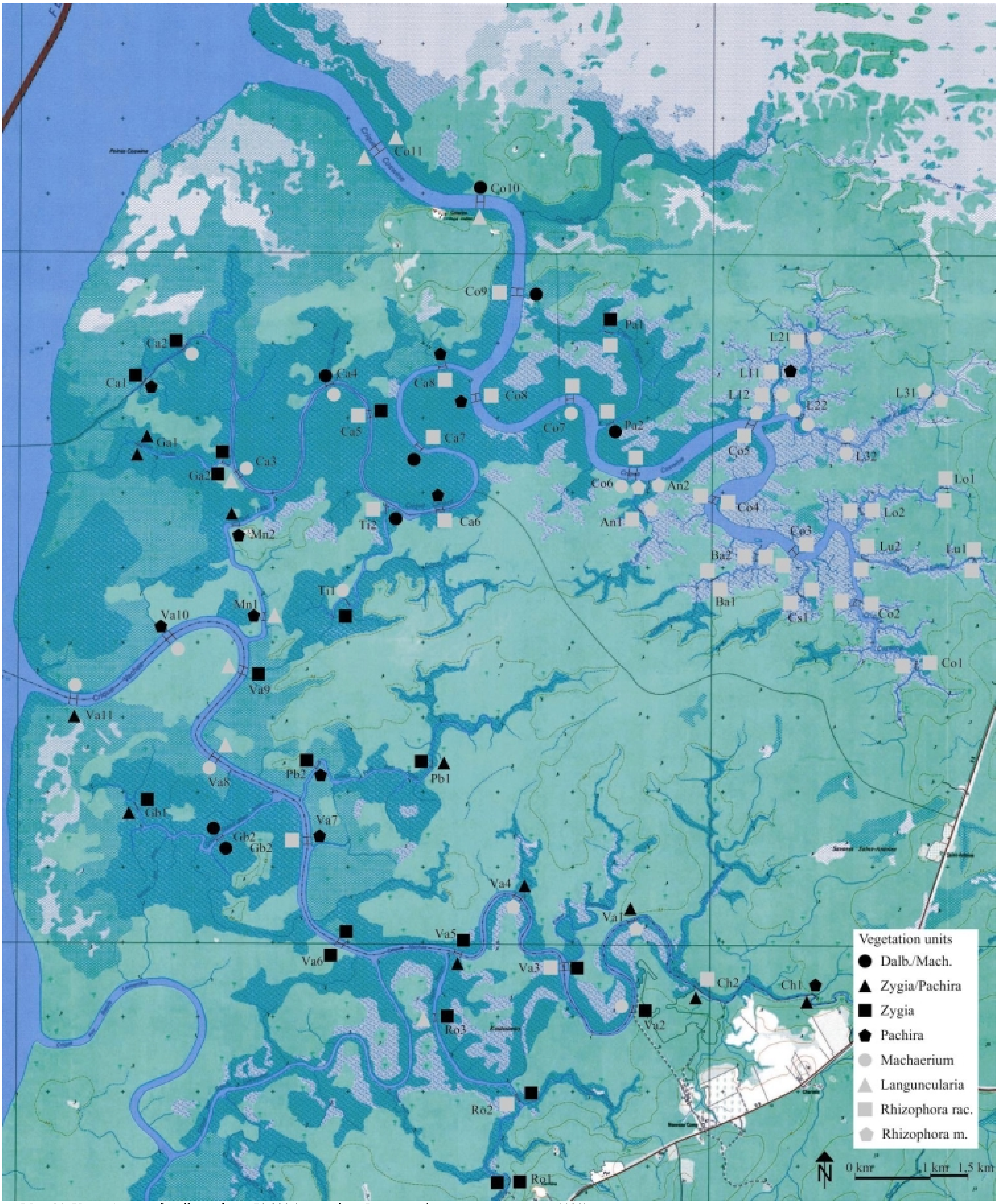
In contrast to the subgroup with low species richness, the second alliance had a higher species richness (8 different plants in each transect), a higher diversity index (1,801) and a higher evenness (41 %) as well. As the sample size was lower (31) and the number of found species higher (49), *S/S* was higher compared to the first subgroup augmented (1,123).

Unit 7 –*Pachira aquatica* mangrove

This is the formation with the highest diversity (2,141), the most even distribution (49 %) and the highest *S/S* (0,941) for the classification of all samples. The species number (ten) was as high as in the *Zygia cataractae*/*Pachira aquatica* mangrove. In total, eleven samples were investigated. In this formation, some other plants were present once in high abundance (class 25): *Crinum erubescens* (in total in 36,4 % transects present) and *Allamanda carthartica* (18,2 % of all transects). *Pachira aquatica* and *Dalbergia monetaria* were found in all samples with an abundances between 5 – 75. These species were accompanied by *Hippocratea volubilis*, a liana, was present in 63,7 % of all cases with an abundance between 0,5 and 25. Further some Arecaceae like *Desmonchus orthocantus* (18,2 % / abundance 0,5), *Desmonchus polycantus* (27,3 % / 0,1 - 0,5), *Euterpe oleracea* (27,3 % / 0,5 - 5) and *Mauritia flexuosa* (18,2 % / 0,5 - 5) were present.

Unit 8 –*Zygia cataractae* mangrove

21 transects were combined to this group. Diversity (1,655) and evenness (38 %) were high. An average sample normally had 7 different species (*S/S* = 0,652) of which *Rhizophora racemosa* and *Zygia cataractae* were the most important and found in all samples with abundances between 5 - 75. *Pachira aquatica* was present in 61,9 % of the samples and forms a sub-association with an abundance of mainly 5. In contrast to the previous unit, no palm species, neither *Crinum erubescens* nor *Allamanda carthartica* was found in this mangrove formation, but *Montrichardia arborescens* (60,0 % / 0,5 - 25) and *Dalbergia monetaria* (70,0 % / 0,1 - 5) were present frequently. Further important species were *Machaerium lunatum* (45,0 % / 0,1 - 25) and *Rhabdadenia biflora* (35,0 % / 0,5 - 5).



Map 14: Vegetation map for all samples, 1:50 000 (extract from INSTITUT GÉOGRAPHIQUE NATIONAL 1990)

5.2.5 Vegetation classification of the combined samples

When regarding the combined samples, the number of transects will be reduced to N = 42. These samples can be classified into four units by means of a cluster analysis. In contrast to the formerly described classification of all samples, the evenness of all combined samples is higher (E_{comb} = 37 %, E_{all} = 22 %) and so is the index of diversity (H_{comb} = 1,432, H_{all} = 0,960).

Two groups can clearly be distinguished (cf. Fig. 35) and already separated on a very high level in the dendrogram. First, the *Dalbergia monetaria* mangrove with *D. monetaria* as constantly present plant. Here, the median of *R. racemosa* was lower (15) and the minimum (0) as well. The maximum was also at 75, but the *R. racemosa* was only dominate in eight cases (38,1 %). Secondly, the *Rhizophora racemosa* dominated mangrove, where *R. racemosa* had a median occurrence of 75 with the minimum at 4 and the maximum at 75. Except for two samples, *R. racemosa* was the plant with the highest abundance index.

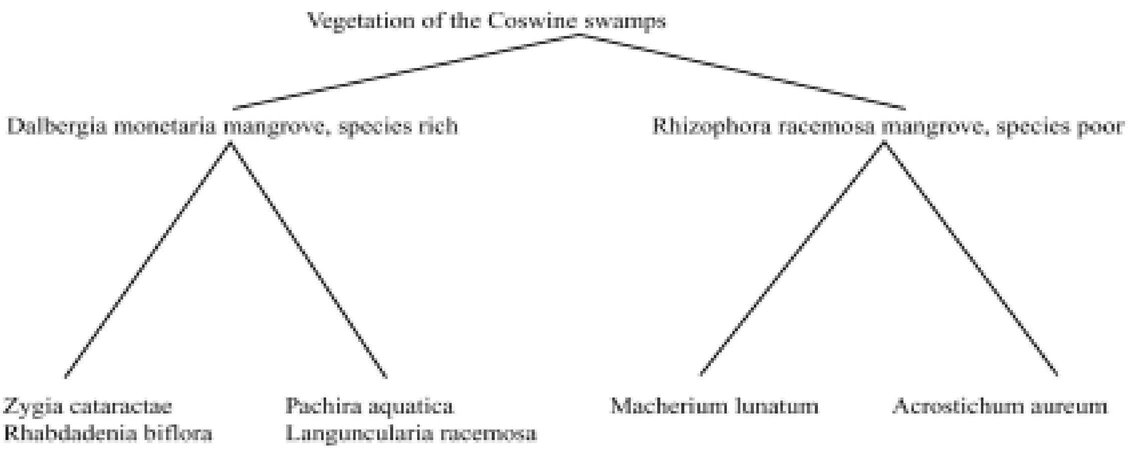


Fig. 35: Hierarchical diagram of the combined samples

Group A* –, *Dalbergia monetaria* mangrove, species rich

In most cases, *Rhizophora racemosa* was still present, but to a smaller degree than in the next group. One species occurred in all samples: the liana *Dalbergia monetaria*. Its abundance was not very high, the minimum at 0,25, the median at 2,50 and the maximum at 12,50. In total, this group is much richer on species (39 different plant were found) than the *Rhizophora racemosa* dominated stands. When calculating the median of species per combined sample, nine plants were found in average. The index of diversity H = 1,969 and the evenness E = 51 % are higher in comparison to the next group for the same sample size (N = 21), which leads to a higher *S/S* as well (1,468).

Unit 1* –*Zygia cataractae* and *Rhabdadenia biflora* mangrove

15 combined samples were examined to describe this association, in which *Z. cataractae* was always present in abundance classes between 2,50 and 37,50. *R. biflora* had lower abundance classes (0,25 to 12,50) and was not found in 13,3 % of the combined samples. In contrast to the species poor units, the diversity (H = 1,909) and *S/S* (0,894) were much higher, because nine different plants were found per combined samples in average and a total of 30 species. Even when *Rhizophora racemosa* was still well present and often in the highest abundance class, evenness was high (E = 50 %). Sometimes *Machaerium*

lunatum (2,50 – 37,50) was found in high abundance classes and could be used to distinguish two sub-units. Further, *Pachira aquatica* (60,0 %, 0,25 – 15,00), *Languncularia racemosa* (40,0 %, 0,25 – 12,50) and *Montrichardia arborescens* (73,3 %, 0,11 – 2,50) were plants which regularly occurred.

Unit 2* –*Pachira aquatic* and *Languncularia racemosa* mangrove

The second unit is the species richest of all groups. At only six combined samples, 28 different species were found with in average 12 plants per combined transect. The diversity therefore was very high (H = 2,379) just as *S/S* (1,236). Dominating plants were hardly recognisable and evenness was high with E = 62 %. The plants often found, were *Machaerium lunatum* (66,7 %), *Zygia cataractae* (66,7 %), *Pachira aquatic* (83,3 %), *Languncularia racemosa* (83,3 %), *Montrichardia arborescens* (50,0 %), *Rhizophora mangle* (66,7 %), *Pterocarpus officinalis* (50,0 %), *Virola surinamensis* (50,0 %) and *Clytostoma binatum* (50,0 %).

Group B* –*Rhizophora racemosa* mangrove, species poor,

This group with 21 samples is characterised by a low species richness – only four different plants were found on average and 22 different species in total. Therefore diversity index was low (H = 0,480) and *S/S* was next to nil (-0,068). In 52,4 % of all samples, *R. racemosa* had a large dominance and reached the abundance class 75 what explains the low evenness E = 12 %.

Unit 3* –*Acrostichum aureum* mangrove

In this unit, *A. aureum* was present in all samples with combined abundance values between 0,25 and 12,75. Except for two samples (22,2 %) *A. aureum* was the second dominating plant after *R. racemosa*. The evenness therefore was very low (9 %). As only nine plants were found in the nine samples, diversity (H = 0,353) and *S/S* (-0,035) were less as well. *Crinum erubescens* (six times present, 0,31 – 2,75), *Pachira aquatica* (5 x, 0,25 – 0,57) and *Kyllinga brevifolia* (4 x, 0,31 – 0,57) also occurred often. As the abundance values for these plants were very low, no sub-units could be distinguish.

Unit 4* –*Machaerium lunatum* mangrove

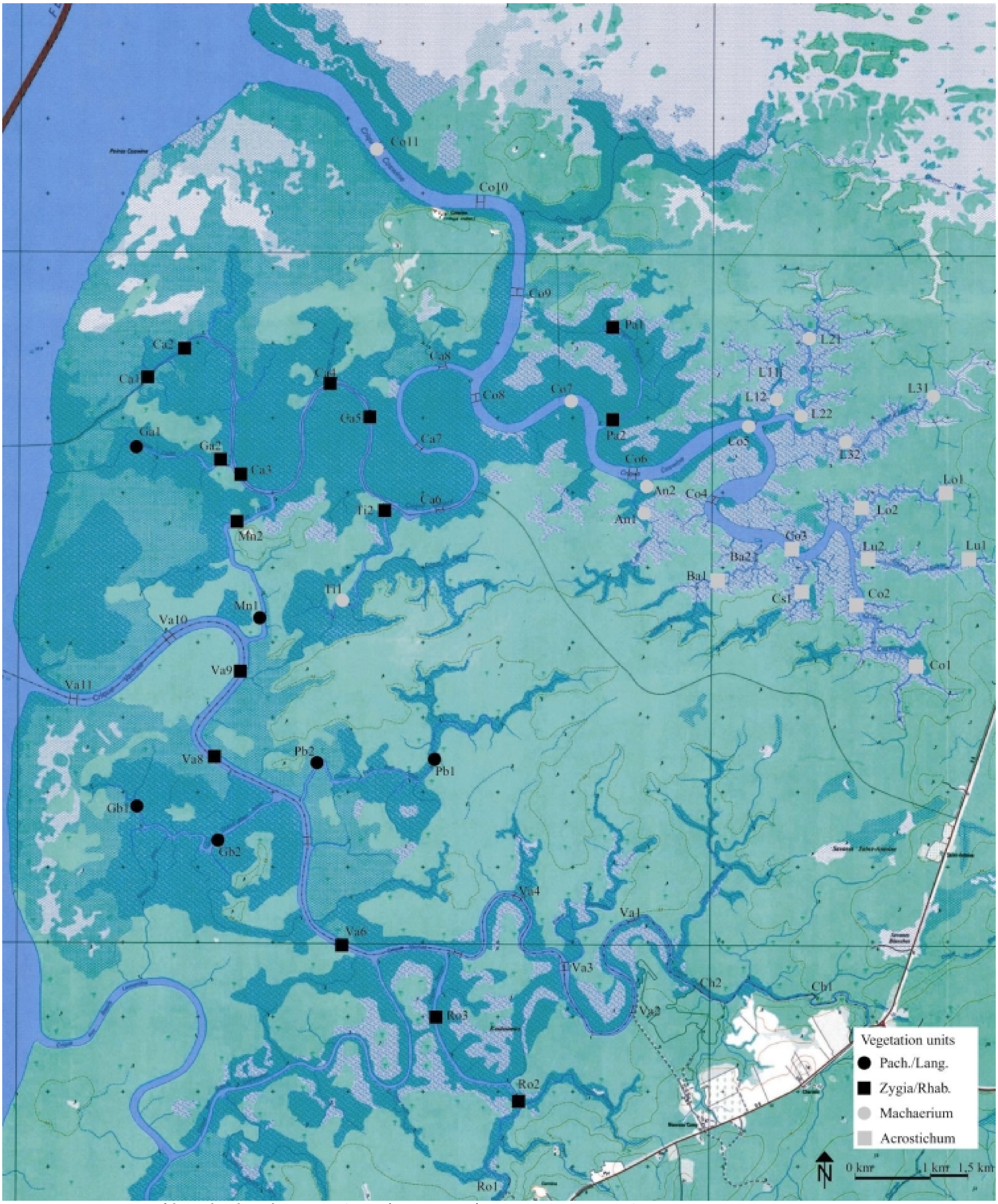
A second unit was formed by *M. lunatum* in high abundance (between 2,5 and 37,5). In two cases, *M. lunatum* was even more dominant than *R. racemosa* (16,7 %). In total, 17 species were found in the 12 combined samples which resulted in an *S/S* of 0,225 and a diversity of H = 0,708. Evenness was higher than in the previous unit 3* (E = 18 %). With the occurrence of *Zygia cataractae* (58,3 %, 0,57 – 5) a sub-unit can be defined, in which *Acrostichum aureum* (41,7 %, 0,25 – 2,75) and *Rhabdadenia biflora* (33,3 %, 0,25 – 0,50) were also frequently present.

The mapping of the four vegetation units clearly shows an accumulated appearance of the *Acrostichum* formations in the upper course of Crique Coswine and its tributaries, beginning eastward from Crique Balata. Nowhere else was could this formation be found (cf. Map 15). It can clearly be associated with the low mangrove. More to the West, the second species poor association (*Machaerium* stands) begins. Out of the twelve samples only one is not part of the Crique Coswine and tributaries system (Ti1). The most divers *Pachira aquatica*/*Languncularia racemosa* stands are concentrated in the Criques Petit and Grand Ben Amar with two outliners in Crique 1900 and the source of Crique Gadet. The last unit is mainly found in the Crique Canard.

Conclusion

The classification by abundance and presence of species shows the overwhelming dominance of *Rhizophora racemosa*. This outstanding importance is underlined by the syntaxonomic classification which separated the *R. racemosa* dominated samples from all others. Only about $^1/_5$ of the species found in the Coswine swamps are relevant for the description of the different vegetation units. The rest appears only rarely or sporadically and in small or without any dominance. For the syntaxonomic classification, these plants have the character of accompanying species.

In both, the classification of all samples and of the combined samples, the presence/absence of *R. racemosa* is in relation with the species paucity/richness. In species rich units the liana *Dalbergia monetaria* forms the contrary unit to *R. racemosa*.



Map 15: Vegetation map of the combined samples, 1:50 000 (extract from INSTITUT GÉOGRAPHIQUE NATIONAL 1990)

5.2.6 Characterisation of the Coswine swamps as a manatee habitat

As the previous chapters showed, the Coswine swamps are on the one hand characterised by a rather homogenous aquatic milieu without any submerged aquatic vegetation and on the other hand by a vegetation dominated by *Rhizophora racemosa*. Manatees demand both: water quality in a manatee fitting range and enough food resources to support a viable population.

The Coswine swamps show similar values of the aquatic parameters in the study area. A differentiation into smaller zones is not useful, as the parameters range is small for each variable and an effect of egalisation would appear when the parameters are regarded together.

Concerning the vegetation, the study area is charcterised mainly by the presence of *Rhizophora racemosa*. Except for *Machaerium lunatum*, a thorny shrub, and *Crinum erubescens*, a Liliaceae which produces alkaloides, no plants seem to be avoided by manatees. The units without *M. lunatum* are the *R. racemosa* mangroves of all and the combined samples. *C. erubescens* is in these units present but only to a small degree.

These formations appear most often in the “lac du bagne” region (cf. Map 14 and Map 15). This zone can therefore described as “more favourable” in an area which generally is well fit to shelter a manatee population. Furthermore, the “lac du bagne” region is very seldomly used for hunting by indigenous people and therefore virtually unvisited by humans (DIJOSEF, pers. comm.).

5.3 Discussion

5.3.1 Manatee observations

The poor observation results were in first place caused by the study design which dealt mainly with recordings of biotic and abiotic factors. Therefore, most of the time was spent with sampling vegetation and water quality and less time was dedicated to quiet and long-time observation efforts. Further, the noisy kind of moving with an out-board motor, is not helpful for sightings of manatees (cf. BERTRAM and BERTRAM RICARDO 1973; SMETHURST and NIETSCHMANN 1999), even if DIJOSEF (pers. comm.) recommended several times that the manatees' attention could be attracted by loud screaming.

As already mentioned in the introduction, the water turbidity also plays an important role for manatee observations and sightings are "far more a matter of chance than plan" (BERTRAM and BERTRAM RICARDO 1973:303). The clarity of the water is very limited and so it is strongly possible, that not all manatees present in the area were seen, a problem that influenced sightings in Brazil (BOROBIA and LODI 1992), Venezuela (O'SHEA *et al.* 1988) and Mexico as well (COLMENERO-ROLON 1985).

Browsed vegetation a good indicator for the presence of manatees (TIMM *et al.* 1986), but it could be only found twice. The cropped plants can easily be recognised by the typical feeding manner of manatees.

Except for the sighting of the one group (cf. 5.2.1), manatees were always spotted at the edge of the creeks near the bank. HARTMANN (1979) suggests that this behaviour – to be seen in Florida as well – may be caused by the currents, which are more slow at the shore than in the middle of a creek. Moreover, it is likely that manatees prefer to swim at the border while searching for food, which can be found only on the banks.

During the study faecal, excrements were also searched for, as described by BEST (1983), but nothing was found. This could be the result of the high velocity at the water surface due to the changing tides. Often, little wave action disturbed the surface and the occurrence of much floating organic matter in particular, when rising tide nearly "stops" the currents, hindered the observations of faecal excrements. REEVES *et al.* (1996) reports the same problems from Peru.

5.3.2 Sampling methods

Recording of the aquatic factors

As already shown in chapter 4.2.3, the measurement of the aquatic parameters provided some difficulty; for example the stronger heating and in consequence a higher water temperature in the afternoon than in the morning. This problem has been already discussed in a previous chapter (cf. Fig. 18). The median values for the stations varies between 26,2° C and 30,1° C in this study and thus is above the minimal temperature fixed for the survival of manatees. This corresponds to the opinion of

BOROBIA and LODI (1992) who do not judge temperature as a limiting factor in their study made at Barra de Mamanguape (Brazil). At least during the time they made their records, water temperature was between 24° C – 26° C. Thus, temperature seems to be negligible for a manatee habitat classification.

Surprisingly, salinity in all creeks was very low. After literature study (cf. BOYÉ 1963; CHOUBERT 1961; JOUNNEAU and PUJOS 1988; LOINTIER and PROST 1986) and from the ecological aspect of the encountered vegetation (mainly Red Mangrove), it was expected that the area was totally and to a high degree invaded by at least brackish water. This difference between the expected and the real result can be based on two reasons: first, the records had been taken at early low tide or after heavy rain. This could result in the fact, that the fresh water flushes out the salt or brackish water and in consequence only freshwater or low salinity values are recorded. But sampling of the aquatic parameters started only when the tide was rising. Therefore, salty water invasion into the creeks should have been observed. As this was not the case, the second reason may be responsible for the mainly fresh water in the area: the records of the parameters were made at the end of the rain season and only the last weeks were in the dry season. During the rainy season no brackish water invades the inland waters (BERTHOIS and HOORELBECK 1968; BLANCANEAUX 1981; LOINTIER 1990; LOINTIER and PROST 1986). Also, the ion concentration is highest in dry season (PAYNE 1986). But when regarding the samples in a temporal order, no risen occurrence could be found. Two stations with brackish water were recorded on the 13th of July, two on the 24th of July, three on the 11th of August and one on the 13th of September. Thus, the Coswine swamps are either not invaded by salt water in the expected quantity or the records were placed at a time of the day when no sea water invaded the creeks, which regarding the number of samples, would be surprising, but possible. A study by BERTHOIS and HOORELBECK (1968) supports the first assumption, as the maximum of salinity was 28 ‰ for a station near La Pointe des Hattes, but even there salinity was next to nil during low tide. At the mouth of Crique Coswine, salinity has its maximum at 2 ‰ and at the mouth of Crique Bœuf aux Lamantins salinity is not exceeding 0,2 ‰. Similar result were obtained by JOUNNEAU and PUJOS (1988) (cf. Fig. 36).

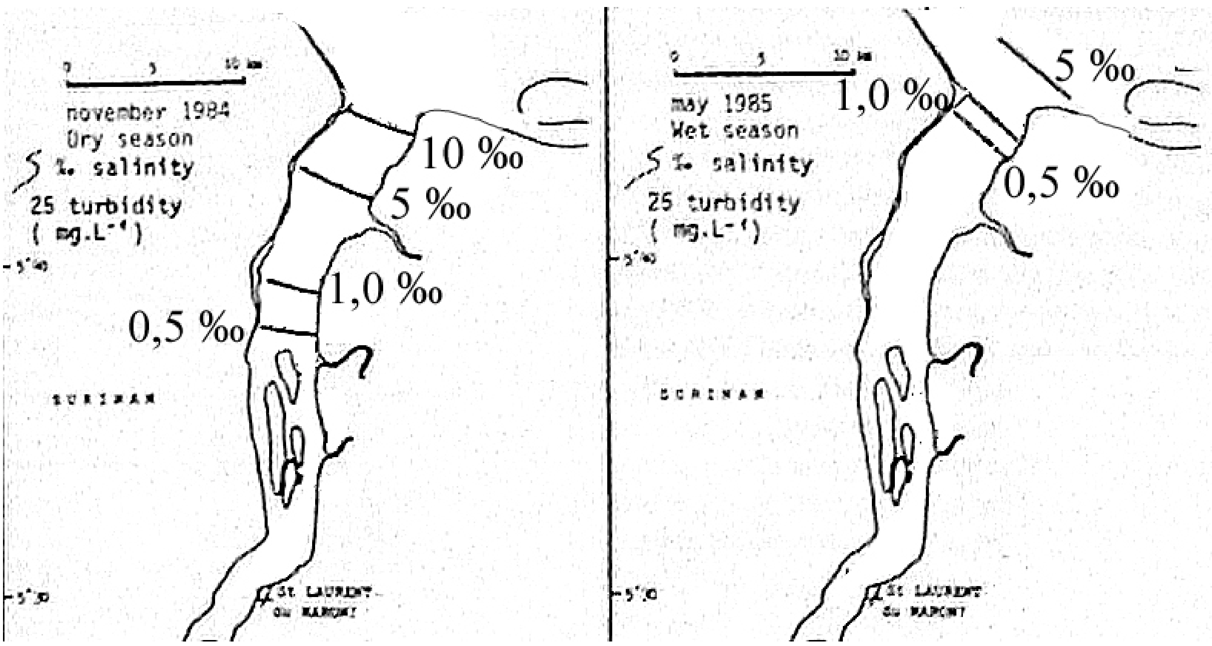


Fig. 36: Salinity in the Maroni in May and November 1984 (after JOUNNEAU and PUJOS 1988)

The depth measurements were very simple, but it was not aimed to get exact profiles of the creeks' bottom. The deepness was most important for acquiring information whether manatees can be locked in shallow creeks during low tide or during the dry season, when the water level is in general lower than in the wet season. At this point, it is important to remember that the difference between the maximal flood and the minimal ebb is 2,7 m. Manatees may get locked any time of the year by falling tide in channels with depth of less than 3,2 m when accounting for a minimal height of 0,5 m for a manatee. But this seems to be to negligible. In the middle of the creeks the minimal median value was 3,0 m and had been reached only once. The lowest measured value for the whole study area was 2,5 m and was taken at the same station. The three other stations where shallow points were found, were all situated in the upper courses of small creeks already beyond or near the limits where manatees may go as the waters become more shallow there.

Recording of the vegetation

For the estimation of the abundance/dominance of a vegetation sample, the Braun-Blanquet scale is quite widely accepted (see for example DIERSCHKE (1994). For the study, this scale was modified and some units aggregated in higher level groups, in particular the Braun-Blanquet classes 4 and 5. The purpose for this accumulation was that the scale was easier to apply and no transformation was necessary for further calculations. After having done nearly half of the field work, it appeared that the chosen scale was too rough for high abundance (e.g. in the class 25 and 75), a problem which is also mentioned by DIERSCHKE (1994) in connection with the Hult-Sernander-scale, a pure dominance scale, which is similar to the classes 25 and 75 to the scale applied here. In these groups it would have been better to subdivide the two classes in three smaller ones. This may look like the proposition in. Tab. 10. And here, the disadvantages of the previous scale are eliminated. In the upper classes, a differentiation between samples with "total" dominance (over 75 %) and less abundant species can be made. At the same time, this scale allows to name less abundant species in a sufficient way. For vegetation samples in the Coswine swamps, the difference between the classes r and + is not highly important, as there are only few small plants especially grasses. Lianas normally cover a large surface and are therefore, despite their small habit, often occur in abundance classes exceeding 0,1. At the time when these problems became clearly visible, nearly half of all stations had been investigated. So, it was to late to rebegin the sampling with a better adapted scale.

Braun-Blanquet scale		abundance classes
r and +	< 1 %	0,5
1, 2	1-10 %	5
2	11 - 25 %	17,5
3 and 4	26 - 75 %	50
5	> 75 %	87,5

Tab. 10: Proposition for a better adapted estimation scale

The big variations between the flood and the ebb could have led to miss some small submerged plants thriving on the edges of a creek, as they could have been flooded and not been seen during high tide. The organisation of the study was determined by the fact that the sampling of the aquatic parameters was only possible during high tide (see above). Thus, the vegetation was mainly recorded during low tide and normally all plants should have been seen. Moreover, the huge quantities of food which are consumed daily by a single manatee lead to the assumption, that small and rare species do not play an important role for the characterisation of the manatee's habitat.

The meandering course of most of the creeks caused some problems. It rarely happened that a transect was straight and not curved. Especially in the smaller tributaries, where meanders are more numerous, the transect can be slightly shorter or longer at one bank than one the opposite bank. Sometimes “holes” in the clear gallery line of the mangrove’s limit towards the creek appeared. In these cases, the vegetation was sampled in a straight line and the presence of a hole was noted on the sheet. When a transect was strongly curved, the distance was also measured on the left bank. But for the definition, which stations were “heavily” curved and where it was not necessary to do a second distance measurement, no criteria were imposed.

5.3.3 Classification and interpretation of the aquatic parameters

The classification of the aquatic parameters must be regarded with caution. Surely the division into areas with a similar ranges for one parameter could be pushed further on, but it is doubtful whether such a forced classification is useful and necessary for a more exact description of the manatee habitat. The differences for one parameter were small and could only represent daily changes and not determining values for a certain area. To get more exact data to provide a better understanding of the values, a year-around lasting study with numerous fixed record stations distributed in the whole study area would be an advantage.

In comparison, some key values of Sinnamary river, the third largest river in French Guiana, are given: the temperature was recorded during a study made by MERIGOUX and PONTON (1999) from March 1995 to October 1996 in average with 24,7° C for the downstream region, and the pH with 4,6 for the same area. The mean oxygen content was given with 5,2 $^{mg}/_{l}$. In the present study, the temperature was higher, but MERIGOUX’S work does not take into account the influence of the tides, as the estuary was not investigated. Secondly, the study covers the two wet seasons. The oxygen content is higher than in study in hand because the Sinnamary river is faster flowing and rapids are numerous, while the water in the Coswine swamps is slowly flowing and no rapids are encountered. As sea water regularly dilutes the creeks in the Coswine swamps the pH is raising and higher than in Sinnamary. For the Maroni, a study was undertaken in March 1963 by BERTHOIS and HOORELBECK (1968) who worked mainly on the sedimentation, but salinity was also recorded. The results were already mentioned in chapter 5.3.2 Sampling methods .

5.3.4 The vegetation and its interpretation

Dominance of species

The absolute dominance *aD* combines the species’ presence and its abundance in one formula and gives a good impression of the species’ importance. On the first sight the formula seems to be very complex and the necessity of the denominator is not clear, as the tendency would also appear clearly when the number of species is only multiplied by the abundance class. The advantage of the *aD* in the chosen form is that the result for this study is between 0,001 and ca. 100. Without the denominator, the range of the *aD* would be larger, namely from 0,1 to 9300.

Further, the absolute dominance allows to make some statements on the dominance and abundance of a species. A nearly omni-present plant like *Rhizophora racemosa*, which was moreover only present in high abundance, has a very high *aD*. The *aD* gives a mathematical test for the assumption that this species is very dominant in the whole study area. The smaller *Rhabdadenia biflora* will have an *aD* of 0,59, even when it is present 39 times, and therby as often as *Dalbergia monetaria*, but this species reaches an *aD* of 3,02, because of its raised appearance in high abundance classes.

Mean number of species versus median of species and index of diversity/evenness versus S/S

In plant sociological literature (DIERSCHKE 1994; DIERßEN 1990) the mean number of species in a sample is a common term. In statistical literature (ENGEL 1997; LAMPRECHT 1999; LOZÀN and KAUSCH 1998; SACHS 1999) it is stressed that the calculation of the mean number of a sample will only be allowed, when normal distribution is guaranteed. If not, the median or the mode, which is even more correct when the distribution is very uneven, but is seldomly applied in biological studies (LAMPRECHT 1999), should be used. Especially for small samples, the median is recommended as the appropriate tool for characterisation of such a group (LOZÀN and KAUSCH 1998). Therefore, in the present study the median is used – against the common practice –for the description of the average number of species per transect or vegetation unit.

Index of diversity and evenness are also widely used methods to describe and compare vegetation units (cf. chapter 5.1.1). Nevertheless, it seemed to be useful to introduce a further formula to describe more precisely the relation between the number of species per transect and the number of samples. The diversity index only considers the abundance of a species. As it is derived from the diversity index, the same is true for the evenness. In contrast, the *S/S* is based on two parameters: the relative number of species and the relative number of samples. Standardised by the functions sine and cosine, it oscillates between the limits –2 and 2. This allows diversity comparison between vegetation units with different numbers of samples. Together with the index of diversity and the evenness, the *S/S* is a well applicable tool and helps to characterise vegetation units from a diversity's point of view.

Low evenness values indicate that some plants are dominant. This can be shown when regarding the difference between the *Rhizophora racemosa* unit and *Zygia/Pachira* stands: for the first one, evenness, diversity and *S/S* is very low, for the second one, these values are high. When regarding the floristic composition of the samples individually it can be seen that in the *R. racemosa* unit, the Red Mangrove is always widely dominant, while in the other unit, the highest abundance class is at least represented two times per transect except for three of the eleven samples (27,3 %). On the other hand, high evenness values stand for a rather equal distribution of the found species in dependence of all found plants. The highest values for the evenness are found in the *Pachira/Languncularia* unit.

The vegetation units and its ssignment to existing syntaxonomic classification systems

LINDEMAN (1953) describes the swamps and mangroves in Suriname, but he does not give any syntaxonomical indications. In three chapters he explains the mangrove, herbaceous swamps and swamp forest.

According to LINDEMAN, *Rhizophora* plays a major role in the estuarine mangrove, but when water is fresher, *Montricharida arborescens* appears and forms dense stands. This observation was not made in the Coswine swamps. In the *Zygia/Pachira* unit, *M. arborescens* reaches its maximal dominance, but *R. racemosa* is either absent or in most cases present in abundance class 5.

In the chapter "swamp forest" Lindeman reports of a *Machaerium* scrub, which thrives well even in polyhaline to fresh water on the edges of creeks.

A formation named "*Symphonia globulifera* type", is mentioned as accompanying creeks and inland waters, where *Pachira aquatica* is very common. Together with *Tabebuia*, *Pterocarpus* and

Virola the association may spread out into real swamps, but the author did not give any supporting data. But he added some more plants which occur in this swampy formation: *Euterpe oleracea*, *Mauritia flexuosa*, *Maximiliana maripa* and *Tabebuia*. Surprisingly, *Zygia cataractea*, very common in the study in hand, is not mentioned in his work. SCHNELL (1987) mentions a bank association of creeks with *Pterocarpus officinalis*, *Montricharida arborescens* and *Pachira aquatica*, and with *Inga* on the concave side of meanders. LESCURE and TOSTAIN (1989) mention back mangrove, where *Symphonia globulifera* and *Virola surinamensis* occur and a transition zone to swamps, when *Pterocarpus officinalis* and *Montricharida arborescens* are found in heaped stands.

Compared to units yielded in this study, some similarities appear. The species rich units are characterised by many plants, which LINDEMAN put into the section of swamp forest plants. In the *Zygia/Pachira* unit, *Pterocarpus officinalis* is found in high abundance next to *Pachira aquatica*. Furthermore, *Euterpe oleracea* and *Virola surinamensis* are present. It can be assumed that the *Zygia/Pachira* is an association of the swamps. PIRES and PRANCE (1985) in contrast lists *Pterocarpus officinalis* as a mangrove species.

The three associations made by CHAPMAN mentioned above could be represented in the present study by the units *Rhizophora racemosa*, *Rhizophora mangle* and *Langucularia racemosa*. The other units are transistory units from the mangrove to the swamps.

The integration of the vegetation samples carried out into a syntaxonomic system is not altogether without problems (cf. PFADENHAUER 1997). For a correct analysis of the vegetation units not enough samples were taken and comparison with other neighbouring habitats was not made. In the estuaries of all big rivers in French Guiana, estuarine mangrove formations can be found and on first sight, they seem to be comparable to the ones in the Coswine swamps (p.obs.). For the neighbouring countries (Suriname and Brazil) this is also valid. Further, an accepted classification made by CHAPMAN (1976b) already exists. The for the present study interesting formations, mentioned in CHAPMAN (1976b), are:

Rhizophoretalia

Rhizophorion occidentalis

1. Rhizophoretum mangale

2. Rhizphoretum racemosae

Combretalia

Langunculariion

3. Langunculariertum racemosae

Unfortunately, CHAPMAN did not publish in his paper any further information about the species composition in one group, neither about the differential species nor the accompanist.

As the classification made in the present study is afflicted by problems because the above mentioned criteria are not fulfilled and tables with the characteristic species were not found in literature, the vegetation units in the present study were only put in different groups. This is a numerical method and the approach has not the pretension to be a syntaxonmical classification in the Tüxen and Braun-Balnquet sense. Thus, syntaxonomical names were not attributed to them, but the units were labelled by the characterising species of a group. If one group can be distinguished from another by its high species diversity, it got the name of the two most important plants.

The vegetation units were obtained by a cluster analysis, but then aggregated by hand to higher level groups. This is at first a purely mathematical approach and no ecological information is incorporated in the systematic. Only afterwards, ecological knowledge was used to create the groups and the sub-groups. In contrast to a "hand-made" classification, each species has the same importance if it is analysed by clustering. Some finesses and particularities are not taken into consideration (DIERSCHKE 1994). This can be avoided or lowered, when the cluster analysis is used as a first approach and the result obtained is regarded afterwards with ecological understanding. The classification made by the cluster analysis (Fig. 37) differs from the classification (cf. Fig. 34) shown in chapter 5.2.4: it put all species rich units into one group and the species poor ones into another. The hierarchical structure is like shown in the figure below. The different levels of the diagram are obtained by the aggregation of the first yielded eight units to higher level groups, a common method in cluster analysis.

Common points between the two classifications are the same number of units and that in both cases the species rich group can be characterised by *Dalbergia monetaria*, while the species poor one can be call *Rhizophora racemosa* group.

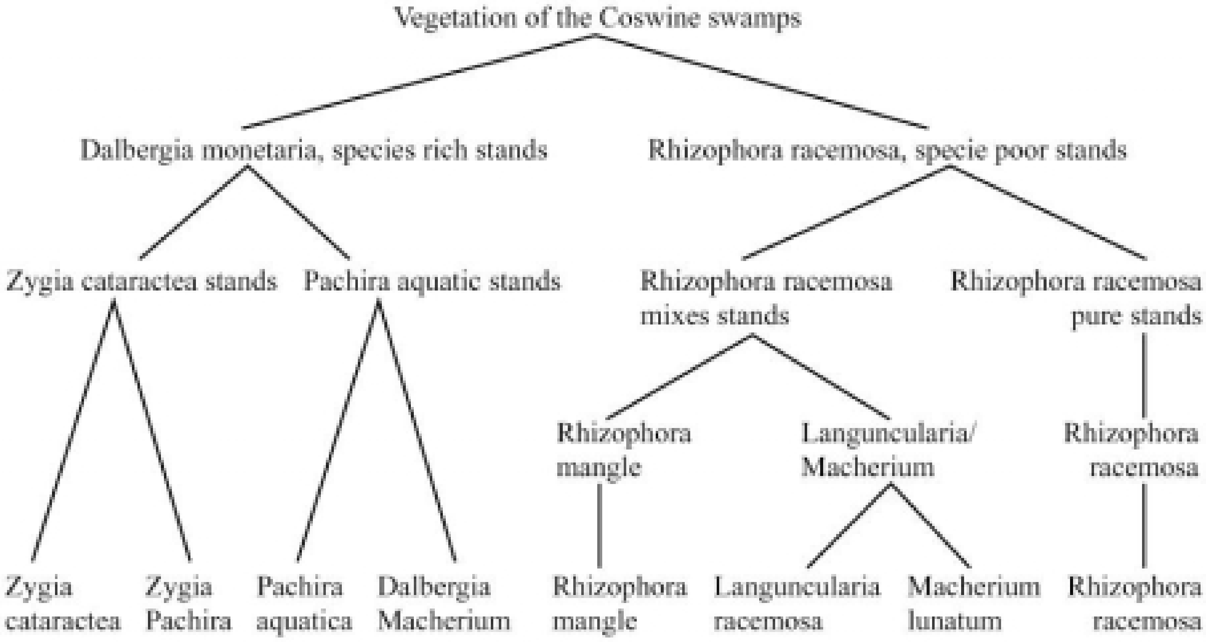


Fig. 37: Hierarchical diagram of the vegetation of the Coswine swamps after cluster analysis

The combined samples approach (see chapter 5.2.5) gave a more coherent picture concerning the occurrence in the field. When mapping all samples, no features will be clearly visible, while the combined samples – in particular the *Acrostichum aureum* unit – are well accumulated and grouped in one area. One reason for this reaction is surly that only four classes exist. Another is that the samples are more well-balanced than the others due to the median values formed by the left and right bank samples. The combined samples have less units, but like the mathematical and the ecological classification of all samples, the two groups are once again characterised by the same species.

Vegetation and the manatee habitat

The nearly pure *Rhizophora racemosa* mangrove seems to provide best food resources for manatees. *R. racemosa* is reported to be eaten (BEST 1981) and species with thorny or other for manatee dangerous habit are not present or in only very small abundance (0,1/0,5).

5.3.5 The Coswine swamps as a manatee habitat

A cluster analysis of the total study area with all parameters did not bring any satisfying results. On the one hand this is based on the big heterogeneity of the data, with different ranges for all parameters. LOZÀN and KAUSCH (1998) request for a cluster analysis to omit all extreme values that could falsify the results. On the other hand, parameters with a small range are to be put aside, as they can not be called "variables" when they do not vary in a specific range (LOZÀN and KAUSCH 1998). A standardisation or transformation finally only tests the standardised or transformed values and no longer the in reality recorded ones (ENGEL, pers. comm.). Finally, no classification of the Coswine swamps with all parameters was made, as the result of the test did not bring good results.

It is clear that vegetation is not an indicator of manatee presence, as manatees are mobile and swim from one habitat to another. But if consumable vegetation is available, manatee may travel to these zones and live there if other factors are preferable as well. But the range of distribution is limited by natural frontiers, as a recent study of mitochondria showed (GARCIA RODRIGUEZ *et al.* 1998). The lineages of one group is limited to the Guianan shield. Moreover the wide plasticity of manatees in food questions allows the species to consume a wide variety of plants (BOYD *et al.* 1999; CAMPELL and IRVINE 1977; O'SHEA 1986), even algae (LEWIS *et al.* 1984) or mast (O'SHEA 1986).

The high velocity of the Maroni (max. 6,2 km/h just before the ebb) seems to affect manatee distribution only temporally and for a short period.

5.3.6 Comparison with already described habitats

Most descriptions of manatee habitats are more anecdotal than exact and precise. So it is rather difficult to find good reports from existing and studied areas. In Belize, manatees live in extensive mangroves and creeks opening into the sea (Charnock-Wilson in CARIBBEAN ENVIRONMENT PROGRAMME 1995), similar to the habitats in Colombia (CARIBBEAN ENVIRONMENT PROGRAMME 1995), comparable to the situation in the Coswine swamps.

It seems that the only food resource for manatees in the Coswine swamps are the mangrove leaves. From Eastern Venezuela, O'SHEA *et al.* (1988) report a similar habitat during the dry season, where manatees browse mainly on mangrove leaves, as there are virtually no aquatic plants available for manatees in this period.

Further, no seasonal behaviour, as it is known from populations in Mexico (COLMENERO- ROLON and ZÁRATE 1990) or Brazil (BOROBIA and LODI 1992), is reported for manatees in French Guiana (de Thoisy, pers. comm.). In Panama, manatees live in fresh or brackish water like in the Coswine swamps, but not in salt water (MOU SUE *et al.* 1990).

TIMM *et al.* (1986) reports from Ecuador that the water temperature in creeks where *Trichechus inunguis* lives, ranges from 25,0° C to 30,7° C and pH from 5,5 to 6,0, which can be described as similar to the Coswine swamps (here, the median temperature is between 26,2 °C and 30,1 °C and the pH ranking from 5,6 to 6,8).

In Mexico, MORALES-VELA *et al.* (2000) describes the manatee habitat at Chetumal Bay with a water depth of one to seven meters (mean 3m), salinity ranging from 8 ‰ to 18 ‰ and a temperature from 24,5 °C to 31,0 °C. Similar values are given by AXIS ARROYO *et al.* (1998) for the whole state of Quintana Roo. Thus the temperature is even lower than the median temperature in the Coswine swamps, while the salinity is higher than in the present study site (0,0 ‰ to 1,3 ‰). The depth of the creeks in Coswine are also similar to those in Mexico, as the median is only 0,5 m deeper for the banks.

The highest value for the lowest minimal temperature for manatees in Florida is given by IRVINE (see chapter 3.2.3) with 24° C. During the present study which took place at the end of the long rain season, the measured minimal temperature was at 24,5° C. It is therefore not likely that the water temperature falls even under 24° C, as the minimal temperature is reached at the maximum of the wet season mid-June.

5.4 Prospects of conservation and further research programs

The study showed that the water quality in the Coswine swamps is in a manatee fitting range and food in the form of bank vegetation is abundant. Therefore, the Coswine swamps are a zone which is favourable for the conservation and the protection of the species. Manatees can find quiet areas there nearly without human impact and sheltered for heavy surf from the sea. Thus, it is recommended to keep the Coswine swamps in their actual state and to enlarge the protection area situated in the North to the Coswine swamps. This approach would imply at the same time a reinforcement of the conservation for the quite untouched fauna and flora in the area. The involvement and the participation of the local people in particular the habitants of the village of Coswine must be guaranteed, because if protection is installed by the local authorities only, perimeters would not be accepted.

For the successful conservation of manatees in French Guiana, some efforts should be made mainly in the field of education programs, as it is done in Puerto Rico (REYNOLDS *et al.* 1995). This may lead to a sensibilisation of the local populations, which often have lost the traditional relationship to manatees or do not have any information on the species (DE THOISY *et al.* 2001). It is therefore planned by KWATA to edit a leaf-let with short information on the species' importance, traditional interest and actual threats. In connection with eco-tourism, which should become more important in the next years (DESBOIS, pers. comm.), knowledge on manatees may become more widespread, but on the other hand, more eco-tourism also means increasing boat traffic and more disturbance of the up to now nearly untouched Coswine swamps. Together with a probable increase of tourism in the region, the sale of little emblems with manatee or other things in connection with sirenians, can be a source of income for local people and at the same time, the existence of manatee would become more known. In Florida one of the main marine mammal attractions are manatees (TWISS and REEVES 1999). According to local people, sightings are frequent in the region of Coswine even despite the turbid water.

Habitat alteration due to construction of dams or implantation of industry like it is reported from Venezuela (O'SHEA *et al.* 1988) will be not probable in the next years or even not at all in the Coswine swamps, even though a harbour project at the end of Crique Coswine is in public discussion (DESBOIS, pers. comm.).

For a better understanding of the species, radio tracking could be one tool to assess daily travel routes and the main residences of manatees. Some difficulties for that approach are the high costs and the protection of the species, but the procedure is frequent and recommendations are given by many authors (for instance DEUTSCH *et al.* (1998). The entire protection of the species, which forbids to catch the animals, may be a further reason not to work with this method. Year-round measurements of the aquatic parameters were already mentioned as important to get more exact data on the water composition. Further it may be interesting to work on the rostral deflection of the manatees snout, which can give an idea of the consumed vegetation: it can be hypothesised that rostral deflection is – similar to manatees in Panama which live more in fresh water or brackish environment than in seagrass dominated areas (MOU SUE *et al.* 1990) – about 30° or less degrees.

5.5 Summary

The study of the bank vegetation and the aquatic parameters showed a large dominance of *Rhizophora racemosa* in the study area. As this plant supplies good food resources for manatees, the habitat seems to be well qualified for a huge manatee population from a nutritional point of view. The other determined specific parameters are also in a manatee fitting range. Salinity was low in comparaison with other habitats low. Furthermore, the Coswine swamps are in a large part quite untouched from humans and as the secretive behaviour of manatees makes them to a hardly visible animal, the future for manatees in the Coswine swamps should not be too bad. But too much optimism seems to be inappropriate. The increasing boat traffic and the beginning of the eco-tourism in the area in connection with the Great Leatherback laying sites increases the fear that observations of manatees could be forced. But on the other hand, sensibilisation of the local people seems to be important to prevent manatees for being slaughtered only for small ear bones.

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7 Appendix

7.1 List of found plants

Familiy	Name
OLEANDRACEAE	**Nephrolepis bisserata** (Swartz) Schott
PTERIDACEAE	**Acrostichum aureum** C. Linnaeus
ANNONACEAE	**Rollinia exsucca** (A.P. De Candolle ex Dunal) A.L. De Candolle
ANNONACEAE	Species 1
APOCYNACEAE	**Allamanda cathartica** Linnaeus
APOCYNACEAE	**Rhabdadenia biflora** (N.J. Jacquin) Müller-Argoviensis
APOCYNACEAE	Species 1
ARACEAE	**Montrichardia arborescens** (Linnaeus) Schott
ARECACEAE	**Desmoncus orthacanthos** Martius
ARECACEAE	**Desmoncus polyacanthos** Martius
ARECACEAE	**Euterpe oleracea** Martius
ARECACEAE	**Mauritia flexuosa** Linnaeus f.
ARECACEAE	**Maximiliana maripa** (J.F. Correa da Serra) Drude
BIGNONIACEAE	**Clytostoma binatum** (Thunberg) Sandwith
BIGNONIACEAE	**Pleonotoma albiflora** (Salzmann ex A.P. De Candolle) A.H. Gentry
BIGNONIACEAE	**Tabebuia fluviatilis** (J.B. Aublet) A.P. De Candolle
BOMBACAEAE	**Pachira aquatica** J.B. Aublet
BOMBACACEAE	Species 1
BORAGINACEAE	**Tournefortia** sp. Linnaeus
CAESALPINACEAEA	**Macrolobium bifolium** (J.B. Aublet) Persoon
CAESALPINACEAEA	**Macrolobium multijugum** (A.P. De Candolle) Bentham
CAESALPINACEAEA	**Peltogyne venosa** (M. Vahl) Bentham
CAESALPINACEAEA	**Swartzia** Schreber sp. 1
CELASTORACEAE	**Maytenus cf. myrsinoides** S. Reissek
CHRYSOBALANACEAE	**Chrysobalanus icaco** Linnaeus
CHRYSOBALANACEAE	**Hirtella paniculata** O.P. Swartz
CHRYSOBALANACEAE	**Hirtella racemosa** Lamarck **var. racemosa**
CHRYSOBALANACEAE	**Parinari campestris** J.B. Aublet
CLUSIACEAE	Caraipa richardia ?
CLUSIACEAE	Clusia richardia
CLUSIACEAE	**Clusia** Linnaeus sp.1
CLUSIACEAE	**Symphonia globulifera** Linnaeus f.
COMBRETACEAE	**Combretum cacoucia** (Baillon) Exell ex Sandwith
COMBRETACEAE	**Combretum laxum** J.B. Aublet
COMBRETACEAE	**Laguncularia racemosa** (Linnaeus) C.F. Gaertner
CYPERACEAE	**Cyperus luzulae** (Linnaeus) Rottböll ex Retzius
CYPERACEAE	**Eleocharis interstincta** (Vahl) Roemer & Schultes
CYPERACEAE	**Kyllinga brevifolia** Rottböll
CYPERACEAE	**Scleria pterota** C.B. Presl, nomen nudum

Familiy	Name
DILLANIACEAE	**Davilla kunthii** A. Saint-Hilaire
EUPHORBIACEAE	**Chaetocarpus schomburgkianus** (O. Kuntze) F.A. Pax et K. Hoffmann
EUPHORBIACEAE	**Omphalea diandra** Linnaeus
FLACOURTACEAE	**Casearia** N.J. Jacquin sp.1
HIPPOCRATEACEAE	**Cuervea kappleriana** (Miquel) A.C. Smith
HIPPOCRATEACEAE	**Hippocratea volubilis** Linnaeus
HUMIRIACEAE	**Sacoglottis cydonioides** Cuatrecasas
LECYTHIDACEAE	**Couratari calycina** Sandwith
LECYTHIDACEAE	**Couratari multiflora** (J.E. Smith) Eyma
LILIACEAE	**Crinum erubescens** Solander in W. Aiton
LORANTHACEAE	**Phthirusa stelis** (Linnaeus) Kuijt
LYTHRACEAE	**Crenea maritima** J.B. Aublet
MALPHIGACEAE	**Bunchosia decussiflora** W.R. Anderson
MALPHIGACEAE	**Heteropterys multiflora** (A.P. De Candolle) B.P.G. Hochreutiner
MALPHIGIACEAE	**Stigmaphyllon bannisterioides** (Linnaeus) C. Anderson
MALVACEAE	**Pavonia paludicola** Nicolson
MELASTOMATACEAE	**Miconia sp.** Ruiz et Pavon
MELASTOMATACEAE	**Nepsera aquatica** (J.B. Aublet) Naudin
MELASTOMATACEAE	Species 1
MIMOSACEAE	**Entada polystachya** (Linnaeus) A.P. De Candolle
MIMOSACEAE	**Inga cayennensis** Sagot ex Bentham
MIMOSACEAE	**Inga sp. 1** P. Miller
MIMOSACEAE	**Zygia cataractae** (Kunth) L. Rico
MUSACACEAE	Ravelana guianensis
MYRISTICACAE	**Virola surinamensis** (Rolander) Warburg
MYRTACEAE	**Eugenia** cf. **latifolia** J.B. Aublet
PAPILIONACEAE	**Alexa wachenheimi** R. Benoist
PAPILIONACEAE	**Dalbergia** cf. **amazonica** (L.A.T. Radlkofer) Ducke
PAPILIONACEAE	**Dalbergia monetaria** Linnaeus f.
PAPILIONACEAE	**Dioclea huberi** Ducke
PAPILIONACEAE	**Lonchocarpus chrysophyllus** Kleinhoonte
PAPILIONACEAE	**Machaerium inundatum** (Martius ex Bentham) Ducke
PAPILIONACEAE	**Machaerium leiophyllum** (A.P. De Candolle) Bentham
PAPILIONACEAE	**Machaerium lunatum** (Linnaeus f.) Ducke
PAPILIONACEAE	**Muellera frutescens** (J.B. Aublet) Standley
PAPILIONACEAE	**Pterocarpus officinalis** N.J. Jacquin
PAPILIONACEAE	**Vataireopsis surinamensis** Lima
PAPILIONACEAE	Species 1
PASSIFLORACEAE	**Passiflora crenata** Feuillet et Cremers
POLYGONACEAE	Species 1
RHIZOPHORACEAE	**Rhizophora mangle** Linnaeus
RHIZOPHORACEAE	**Rhizophora racemosa** G.F.W. Meyer
SMILICACEAE	**Smilax sp.** 1 Linnaeus
VERBENACEAE	**Avicennia germinans** (Linnaeus) Stearn
LIGNEOUS	Species 1
LIGNEOUS	Species 2
LIGNEOUS	Species 3
LIGNEOUS	Species 4
LIGNEOUS	Species 5

7.2 Record sheet for the preliminary study

Preliminary investigation

Crique:		date:
section:		time:
total number of sections:		

Plot							

Coordinates							
N							
W							

Aqua-chemical parameters							
temperatur: °C							
oxygen: mg/l							
saltinity							
pH:							
water visibility: m							

Depth							
water depth measured: m							
reference water depth : m							
max. water depth m							

Largeur							
meter: m							

Bank vegetation							
Water vegetation							

7.3 Record sheet for the study of the bank vegetation

Record sheet

Code:

Crique:	
transect:	
bank side:	
tide:	

date:	
coordinates: N	
W	
largeur:	m

Aqua-chemical parameters -start-	
time:	
water depth:	m
temperatur:	°C
oxygen:	mg/l
saltinity:	
pH:	
water visibility:	m

Aqua-chemical parameters -middle-	
time:	
water depth:	m
temperatur:	°C
oxygen:	mg/l
saltinity:	
pH:	
water visibility:	m

Aqua-chemical parameters -end-	
time:	
water depth:	m
temperatur:	°C
oxygen:	mg/l
saltinity:	
pH:	
water visibility:	m

Sketch

Vegetation sample

Famil	Species	<0.5m	total	Famil	Species	<0.5m	total
Olear	Nephrolepis bisserata			Euph	Chaetocarpus schomburgkianus		
Pteric	Acrostichum aureum			Hippo	Hippocratea volubilis		
Anno	Rollinia exsucca			Humi	Sacoglottis cydonioides		
Apocy	Allamanda cathartica			Liliac	Crinum erubescens		
Apocy	Rhabdadenia biflora			Lythra	Crenea maritima		
Arace	Montrichardia arborescens			Malph	Stigmaphyllon bannisterioides		
Areca	Desmoncus orthacanthos			Malva	Pavonia paludicola		
Areca	Desmoncus polyacanthos			Melas	Miconia sp.		
Areca	Euterpe oleracea			Mimo	Entada polystachya		
Areca	Mauritia flexuosa			Mimo	Inga cayennensis		
Bigno	Clytostoma binatum			Mimo	Inga sp.		
Bigno	Pleonotoma albiflora			Mimo	Zygia cataractae		
Bigno	Tabebuia fluviatilis			Myris	Virola surinamensis		
Bomb	Pachira aquatica			Papilio	Dalbergia monetaria		
Borag	Tournefortia sp.			Papili	Lonchocarpus chrysophyllus		
Caes	Peltogyne venosa			Papili	Machaerium lunatum		
Celas	Maytenus cf. myrsinoides			Papili	Muellera frutescens		
Chrys	Parinari campestris			Papili	Pterocarpus officinalis		
Clusia	Caraipa richardia			Rhizo	Rhizophora mangle		
Clusia	Clusia sp.1			Rhizo	Rhizophora racemosa		
Clusia	Clusia sp.2			Smilic	Smilax sp.		
Clusia	Symphonia globulifera			Verbe	Avicennia germinans		
Comb	Combretum cf. laxum						
Comb	Laguncularia racemosa						
Cype	Eleocharis interstincta						
Cype	Kyllinga brevifolia						
Dillan	Davilla kunthii			1-5 Ex 0.1; >5 Ex. 0.5; 1-10% 5; 10-50% 25; >50% 75			