PLANKTON AND PERIPHYTON COMMUNITIES

Planktonic plants or phytoplankton, planktonic animals or zooplankton which living free-floating in the water and planktonic plants or animal which growing on stones are covered in this chapter. The phytoplankton is ussually great in excess of the zooplankton. In general, Diatoms or Chrysophyta are the most dominant in the Brantas River.

The abundance and the distribution

Plankton

During the dry season 1997 (Table 10) the abundance of plankton was shown in Karangkates reservoir which is dominated by Chorhormidium. In this site, this species was occupied almost 87% of the total amount of plankton. The abundance are shown also in Ngunut and Surabaya estuary.

In the beginning of the rainy season, the amount decrease in Karangkates without domination of species. The highest abundance is shown in Sengguruh, followed by Wonokromo estuary, Surabaya estuary, Ngunut and Surabaya river (Table 11).

It is to be noted that in both of two seasons the abundance of plankton occurs in the stagnant water or in the reservoirs and in some sites which having a slow current velocity. In the view of species number or diversity, from the upperstream to the lower part of the Brantas river has a tendency to increase. The phytoplankton is ussually great in excess of the zooplankton. Diatoms or Chrysophyta are the most dominant.

Most of sites have a distribution pattern smoothly. In some cases certain sites show a domination of one species especially in the dry season. This domination is shown by Chorhormidium in Karangkates reservoir (87%), Oscillatoria in Lengkong reservoir (80%) and in Wonokromo river (71%) and Spirulina in Surabaya river (71.5%).

The distribution pattern of plankton in the begining of the rainy season shows more spread evenly. The domination occurs only for Microcystis in Surabaya river which occupy almost 72% of the total amount of plankton. Other species such as Scenedesmus are predominant in Wonokromo estuary (43%).

Table 10. Plankton of the Brantas River in the dry season. Represented value in each collum shows the number of cell or individu in each drop of water in the object glass.

PLANKTON (cell/0.05ml)	Sampling Sites												
Dry Season	1	2	3	4	5	6	7	8	9	10	11	total	%
Actinastrum							16				14	30	3.80
Anomoeoneis			4									4	0.51
Characium								10				10	1.27
Chorhormidium						197						197	25.00
Chlorococcum											10	10	1.27
Caelastrum							38				9	47	5.96
Coelosphaerium										1		1	0.13
Cyclotella										1		1	0.13
Diatoma		3	2	14	2		2					23	2.92
Dinophysis									1			1	0.13
Gyrosigma				1		2	15					18	2.28
Kirchneriella										2		2	0.25
Licmophora									1			1	0.13
Microcystis										12		12	1.52
Navicula	6		4	4	7		95	1				117	14.8
Nitzschia			8		15	5					1	29	3.68
Oscillatoria								51		44	47	142	18.00
Pediastrum						8			7		11	26	3.30
Phacus longicanda						15		1	1			17	2.15
Phormidium											1	1	0.13
Pinnularia					1							1	0.13
Scenedesmus											2	2	0.25
Spirulina									30		4	34	4.31
Staurastrum											2	2	0.25
Surirella			3									3	0.38
Synedra		3	2	1	1							7	0.89
Tabellaria	2	2	5		5		19					33	4.18
Tetramastix apoliensis								1	1	1		3	0.38
Trigonophysis arcula										1		1	0.13
Trochiscia pachydesma									1			1	0.13
Ulothrix			13									13	1.65
Total	8	8	41	20	31	227	185	64	42	62	101	789	100.00
Total taxa	2	3	8	4	6	5	6	5	7	7	10		

1. Sumber Brantas, 2. Junggo, 3. Sengkaling, 4. Malang, 5. Sengguruh, 6. Karangkates, 7. Ngunut, 8. Lengkong, 9. Surabaya river, 10. Wonokromo river, 11. Surabaya estuary.

Table 11. Plankton of the Brantas River in the beginning of rainy season 1997. Represented value in each collum shows the number of cell or individu in each drop of water in the object glass.

PLANKTON (cell/0.05 ml)	Sampling Sites												
rainy season	1	2	3	4	5	6	7	8	9	10	11	total	%
Actinastrum					26			15		32	52	125	13.00
Actinosphaerum					1		11					12	1.30
Amphora				3								3	0.30
Anomoeoneis			6									6	0.60
Botryodiopsis							7					7	0.80
Characium			3	3	2	1				2	4	15	1.60
Chorhormidium					17							17	1.80
Chlorella	8				6							14	1.50
Chlorococcum					2			1				3	0.30
Chlorosarcina					19							19	2.00
Closteriopsis						8			2	3		13	1.40
Closterium								1				1	0.10
Cocconeis	4	20				2						26	2.80
Coelastrum					12	18						30	3.20
Cyclotella		2		3	3			2		3	2	15	1.60
Cymbella								1				1	0.10
Diatoma	16	2	3	6						12		39	4.20
Eunotia								1				1	0.10
Fragillaria	1	6	3				2					12	1.30
Gyrosigma							2					2	0.20
Hemidiscus				3								3	0.30
Phormidium						11	5					16	1.70
Melosira									2	2	4	8	0.90
Merismopedia					48							48	5.20
Microcystis									76			76	8.20
Navicula	1	2	3	3	5	2	2		2	5	4	29	3.10
Nitzschia	7		12	3			3		2	2		29	3.10
Oscillatoria			3							5	10	18	1.90
Pediastrum					16	31		16			24	87	9.30
Pleurosigma										2		2	0.20
Scenedesmus			9	12			9	4	20	54		108	12.00
Scenedesmus acuminatus					8		15					23	2.50
Selenastrum											2	2	0.20
Sphaerocystis							31					31	3.30
Spirulina		2	3							2	14	21	2.30
Staurastrum					2	2	3					7	0.80
Stauroneis		2	3	3							2	10	1.10
Surirella		2	3	3	1		3		2	2		16	1.70
Synedra		2			2		2				2	8	0.90
Tabellaria	1	8			1		15	1				26	2.80
Tetraedron						1		1				2	0.20
Total individu	38	48	51	42	171	76	110	43	106	126	120	931	100.00
Total of taxa	7	10	11	10	17	9	14	10	7	13	11		

1. Sumber Brantas, 2. Junggo, 3. Sengkaling, 4. Malang, 5. Sengguruh, 6. Karangkates, 7. Ngunut, 8. Lengkong, 9. Surabaya river, 10. Wonokromo river, 11. Surabaya estuary.

Periphyton

During the dry season (Table 12) the highest abundance of periphyton is reached in Ngunut. Tabellaria is dominant in Ngunut during the dry season and it represents almost 70% of the total amount. In the same season, other species such as Botryodyopis seem predominantly with about 50% occupation.

In the begining of rainy season (Table 13) the highest abundance occurs in Canggu. In this season Ulothrix represent about 72% of the total amount of periphyton. Other species such as Navicula is predominant in Malang (57%) and in Canggu (55%).

Either in the dry and in the rainy season, many species have a wide distribution from the upperstream in Sumber Brantas to the lowerstream in Canggu, these are shown by Navicula, Diatoma, Anomoeneis and Tabellaria.

Table 12. Periphyton of the Brantas River during the dry season 1997. Represented value in each collum shows the number of cell or individu in each drop of water in the object glass.

PERIPHYTON (cells/0.05ml)	Sampling Sites									
Dry season	1	2	3	4	5	6	7	8	Total	%
Amphora	1	1				1		1	4	1.94
Anabaena	5								5	2.43
Anomoeoneis	9	2	3	1	4				19	9.22
Botryodiopsis							9		9	4.37
Coleosphaerium		1							1	0.49
Cymbella					2	5	2		9	4.37
Diatoma	4	1	4	1	1	5			16	7.77
Fragillaria					3		4		7	3.40
Gleocystis		4							4	1.94
Gyrosigma	1			1	2				4	1.94
Melosira		1				3			4	1.94
Navicula	4	1	1	4	2	8		2	22	10.70
Nitzschia			2	1	6				9	4.37
Oscillatoria		5				13			18	8.74
Pinnularia	1								1	0.49
Rhizoclonium		6							6	2.91
Spirotaenia	1	5		1		9			16	7.77
Staurastrum						1			1	0.49
Stauroneis	8		5	1			1		15	7.28
Surirella				2					2	0.97
Synecococcus		3						1	4	1.94
Synedra			1		2		2		5	2.43
Tabellaria		2		1		6		9	18	8.74
Ulothrix			7						7	3.40
Total individu	34	32	23	13	22	51	18	13	206	100.00
Total of taxa	9	12	7	9	8	9	5	4		

Note : 1. Sumber Brantas, 2. Junggo, 3. Sengkaling, 4. Malang, 5. Sengguruh, 6. Ngunut, 7. Ploso, 8. Canggu

Table 13. Periphyton of the Brantas River in the beginning of rainy season 1997. Represented value in each collum shows the number of cell or individu in each drop of water in the object glass.

PERIPHYTON (cells/0.05ml)	Sampling Sites									
Rainy Season	1	2	3	4	5	6	7	8	Total	%
Amphora			1						1	0.25
Anomoeoneis	1	4	1		1	3	1	4	15	3.73
Calothrix						1			1	0.25
Ceratoneis	2								2	0.50
Chlorella		1							1	0.25
Chlorococcum							5		5	1.24
Cocconeis		3				1	2	1	7	1.74
Cyclotella						3		2	5	1.24
Cymbella		1		1		3	8	2	15	3.73
Diatoma		6	3	7		2	2	1	21	5.22
Eunotia				3					3	0.75
Fragillaria	1	1		1		3		2	8	1.99
Gyrosigma			1		1				2	0.50
Lyngbya	2	3			4	1	1		11	2.74
Navicula	7	9	3	35	6	4	4	56	124	30.8
Nitzschia	8		4	11	4		1	1	29	7.21
Nodularia		5							5	1.24
Oscillatoria	1			2	5		6	12	26	6.47
Phormidium							7		7	1.74
Rivularia	11	12						4	27	6.72
Scenedesmus						4		4	8	1.99
Spirogyra	3								3	0.75
Staurastrum						1			1	0.25
Stauroneis			2		1				3	0.75
Surirella						1	1	5	7	1.74
Synedra	2				2			1	5	1.24
Tabellaria	8			1	3	2	1	1	16	3.98
Ulothrix			36					6	44	10.90
Total	46	45	53	61	27	29	39	102	402	100.00
Total taxa	11	10	8	8	9	13	12	15		

Note : 1. Sumber Brantas, 2. Junggo, 3. Sengkaling, 4. Malang, 5. Sengguruh, 6. Ngunut, 7. Ploso, 8. Canggu

Diversity index of Plankton and Periphyton

It has been known that in typical communities there are a few species which are abundant, several species which are less abundant and many species which occur very rare. This model describes the structure of communities of organisms which can be calculated by using diversity index.

According to Hellawell (1985), the use of index of community diversity is based upon the concept that the structure of normal communities may be changed by perturbation in the environtment and the degree of change in community structure may be used to assess the environmental stress.

To consider the diversity of plankton and periphyton community, data on the annexe are calculated by using Shanon-Wiener index. The value is written as "H'" (Odum, 1973; Omori *et al.*, 1984), which describe a symbol of diversity. The higher value of index, the higher diversity in the community. Figure 16 shows that the diversity varied both by the seasons and the sites. These values can be classified into 3 groups as follows:

$H' < 1$: low diversity

$1 < H' < 3$: moderate diversity

$H' > 3$: high diversity

These classified value are often useful for the prediction of environmental stress or the instability of environment. A lower diversity means an instability of environment caused by certain factors, contrarely, a higher diversity indicate a stability of communities in the environment.

Plankton

During the dry season, a lower diversity of plankton occurs in Sumber Brantas, Malang, Karangkates reservoir, Lengkong and Wonokromo estuary, while the other sites show moderate diversity.

In the beginning of the rainy season, the diversity is higher than in the dry season. Most sites show moderate value and there are three sites which represent higher diversity: Sengkaling, Malang and Ngunut.

Periphyton

In the dry season, Junggo has a higher diversity of periphyton. The others show a moderate diversity. In the beginning of the rainy season, a higher diversity is shown in Ngunut and Ploso. The other sites represent a moderate value.

In general, the diversity of plankton from upperstream to the estuary shows very fluctuate during the dry season. Plankton structural communities in the river is very influenced by the change of water and water current. It is clear that the use of plankton diversity index to asses the quality of environment can not be applied for the swift-flowing water, but it can succesfully be applied only for stagnant water.

Periphyton, because they attached on the stones or other materials, can be recomended to asses river condition. Figure 16 shows the same fluctuation for both seasons. A higher diversity in Sumber Brantas and Junggo indicate a good environmental condition and in contrast, Sengkaling and Malang which are situated in the upperstream part of the Brantas River have a relatively lower values. This occurs because these places have a higher nutrients concentration i.e. nitrate and phosphate, as has been written on the previous chapter and because many organic materials exist on these sites. The same pattern is shown also in Canggu.

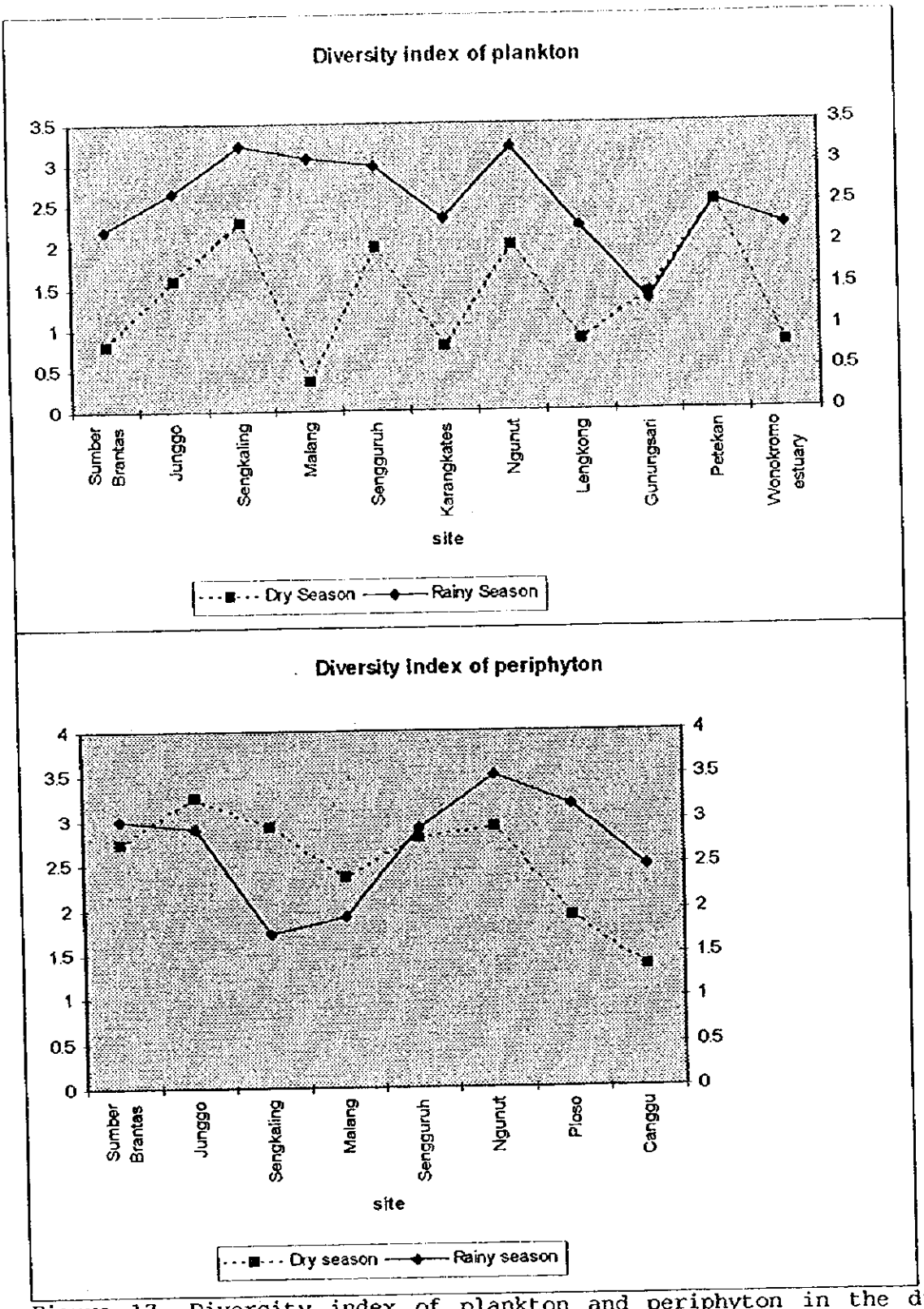

Figure 17. Diversity index of plankton and periphyton in the dry and the rainy season of the different sites of the Brantas River. The value is counted using Shanon-Wiener's equation.

Indicator species.

Plankton, particularly phytoplankton have been used as indicators of water quality. Some species fluorish in highly eutrophic waters while others are very sensitive to organic or chemical wastes. These organisms have a short live cycles, so they respond quickly to environmental changes, and hence the standing crop and species composition indicate the quality of water in which they are found. They strongly influence certain non biological aspects of water quality such as pH, color, taste and odor. Thus, because of these reasons, they are consider as a part of water quality.

Plankton are generaly abundant in lentic environments or in large rivers with slow-current velocity, close to stagnant condition. According to Franson (1985), Plankton is less valuable in assessing water quality in rivers environment, especially in the water which has a swift current velocity. Thus, the use of plankton as bioindicator can only by applied for stagnant water.

In rivers environment where there is a movement and exchange of water, periphyton is more useful in assessing the effect of pollutants. Data taken from the Brantas River may also be classified into different categories. Some organisms are grouped, based on the water quality condition and on the presence of benthic fauna. The consideration of plankton or periphyton to different water quality should carried out with notice to their quantity occurrence in each site.

<u>Indicator of Clean Water</u> :
Anomoeneis
Cocconeis
Diatoma
Rivularia
Stauroneis
Tabellaria

Actinastrum
Chorhormidium
Chlorococcum
Microscystis
Oscillatoria
Pediastrum
Phacus
Scenedesmus
Spirulina

Our observation also shows that *Ulothrix* presence in important quantity especially in the environment where the nutrient, such as nitrate is rich. *Ulothrix* growths are apparently promoted by increased nutrient level, especially nitrate. It is in accordance with the rise the remainder of nitrate from agrarian farms, which dissolved and flown into the river water in Sengkaling and Malang which is followed by the abundance of this species.

The role of plankton-periphyton in biodiversity and their economic aspects

Phytoplankton are highly important as primary producers in aquatic environment. In the food chains they play an important role in providing food for many aquatic animals such as zooplankton, herbivorous fishes, macroinvertebrates, etc.

Because of their photosynthetic activities, they have a role as primary energy source. During daylight they are oxygenating the water in their immediate vicinity, from which are needed by aquatic animals for its respiration and development.

The role of plankton, especially blue green algae, in nitrogen fixation has been known. They fix nitrogen from the air, from this level they can be utilized as a source of nitrogen to fertilize poor nutrient environment.

On the view of their economic aspect, certain species can be monocultured for many purposes. Spirulina can be an excellent substitute for animal protein (Wagener *et al*, 1987), because of its

high nutritive value this species may also have a great future in developing country. Other species such as Chlorella has been known as a supplement or as health food in pharmaceutic industries. The commercial interest in Dunaliella for production of Betha-carotene (Richmond, 1987)is more recent. It may be used as a vitamin A substitute, as an animal feed and as a food colorant.

Problem and solution

The paragraphs above have cited some roles and beneficial uses of plankton. Not all have a positive aspect, there are also negative aspects that should be solved.

1. Algal blooms

Stagnant water in the reservoirs, lakes, ponds or in a very sluggish river which are ample of nutrients (i.e. nitrate, phosphate, etc) may support rich algal blooms. Blooming of alga ussually followed by the rise of oxygen demand for its respiration. Euthophication is a term to the process where lakes are enriched by nutrients naturally or non by human activities. Eutrophic lakes in general are indicated by a low diversity (few species but represented abundantly). In the Brantas Basin, Karangkates reservoir can be regarded as an example, has a lower diversity of plankton during the dry season of 1997.

Certain species, when present in a large concentration, produce disagreable tastes and odours (Palmer, 1985). This may cause disagreable taste to drinking water. Algal deposits originated from blooming of alga may provide further sources of nuissance. Further problem of the rise of oxygen demand from algal blooms, is, this may cause fish mortality.

Eutrophication can be reduced by a better water quality management in the reservoirs. Algal blooms may be reduce physiologicaly by treatments of "unprefered" substance. Some

species have certain "prefered" or "unprefered" nutrients and condition. Further field and laboratory researches are needed.

2. Inflicted plankton

Some species has been known produce toxins, especially red microalga, Dinoflagellate. The toxins could be produced by microalgae when blooms occur and then be concentrated by filtering bivalves or be found in other molluscs or fish. At this level in the food chain that these toxins represent a danger for man. Red microalgal bloom or red tide in general occur in the coastal area seasonaly. In the river environment this may reach the estuarine or brackish water area.

There is in general no information or study concering this subject in Indonesia and especially in East Java. For the time being, this is not a main problem which is faced by the Brantas River Estuary.

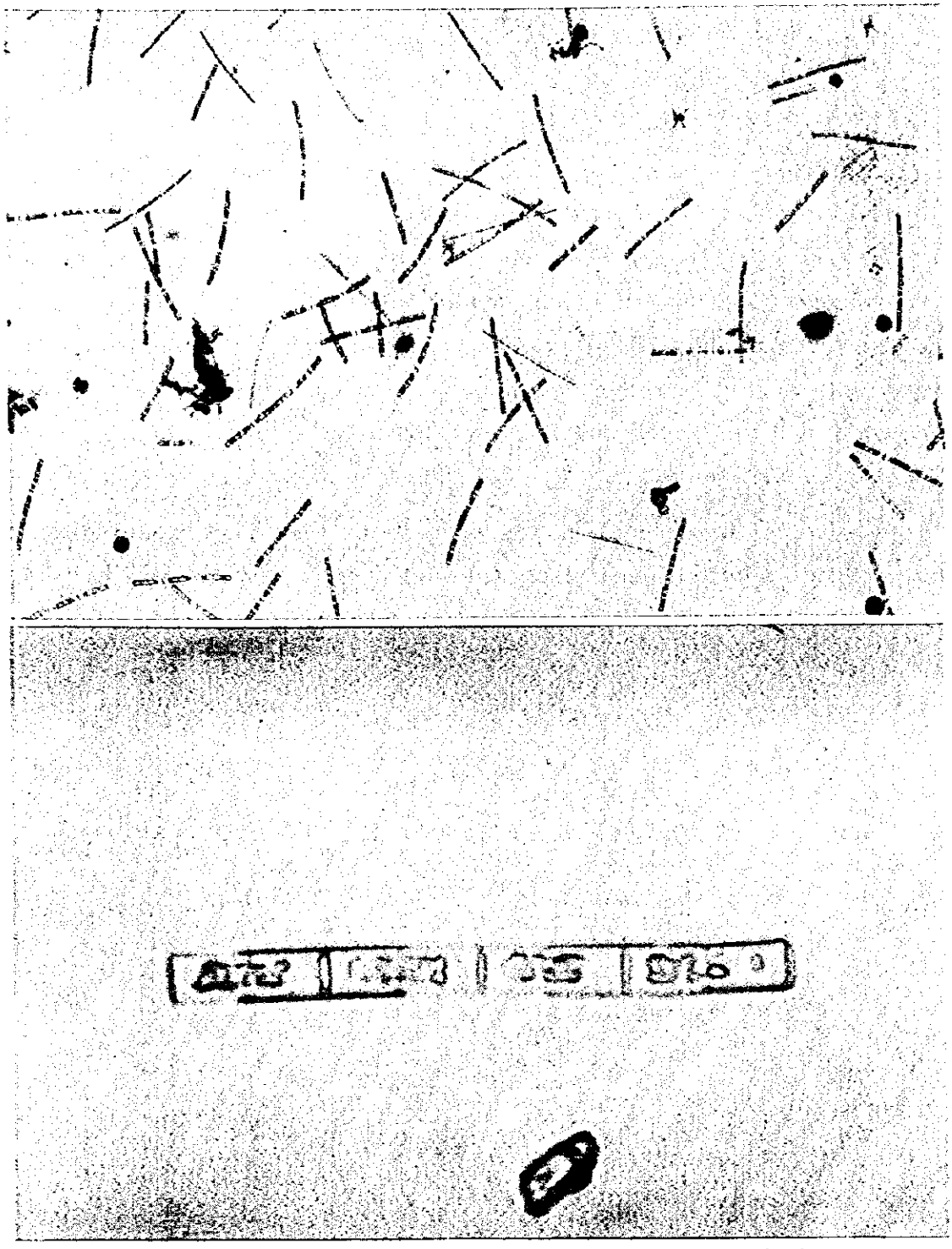

Figure 18. Domination of a species in Karangkates reservoir by *Chorhormidium* (A). Closed view of *Chorhormidium* (B). (Photo: YR)

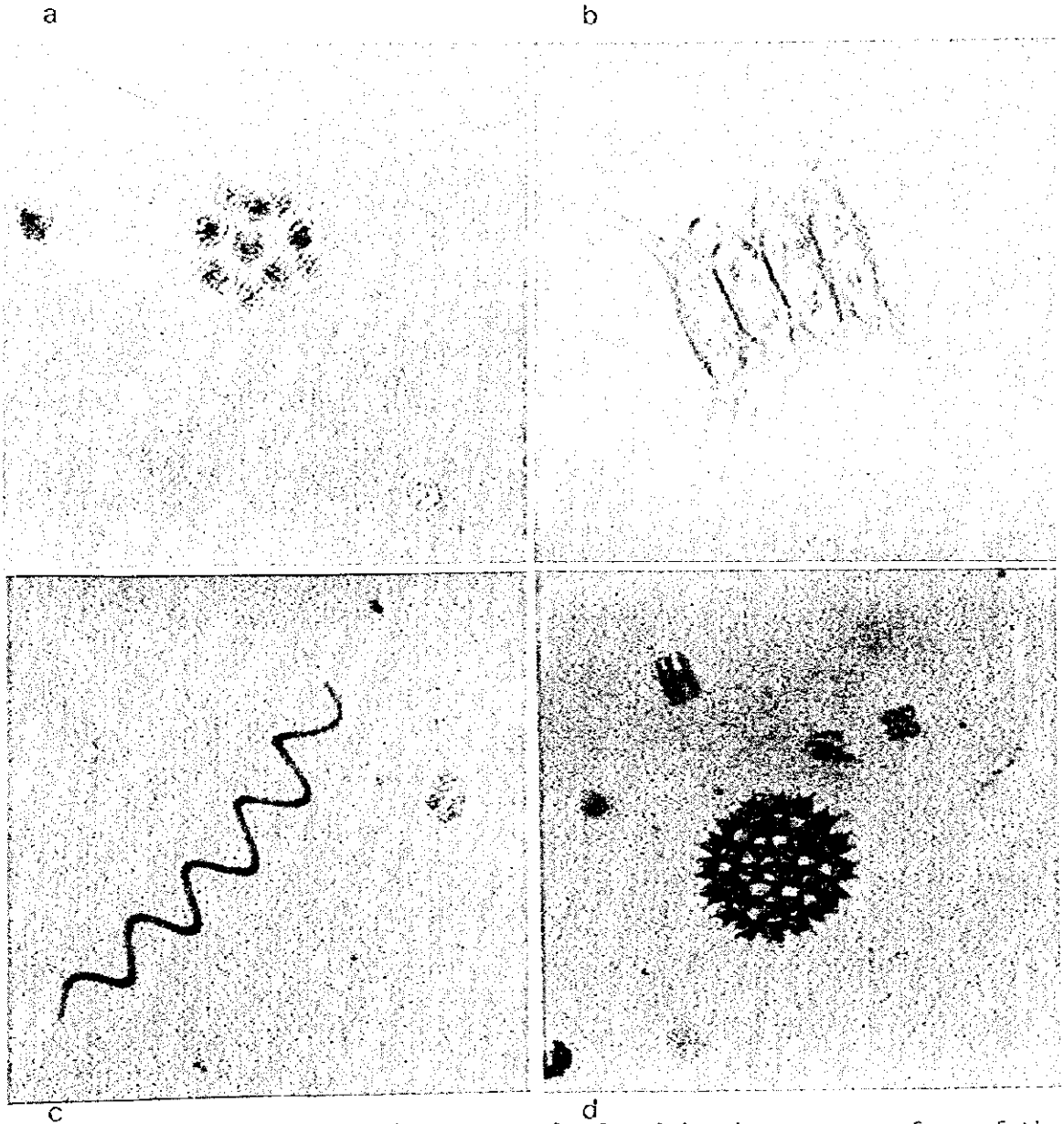

Figure 19. Some of phytoplankton commonly found in the water surface of the Brantas River. A. *Microcystis*, B. *Scenedesmus*, C. *Spirulina*, D. *Pediastrum*. (Photos: YR)

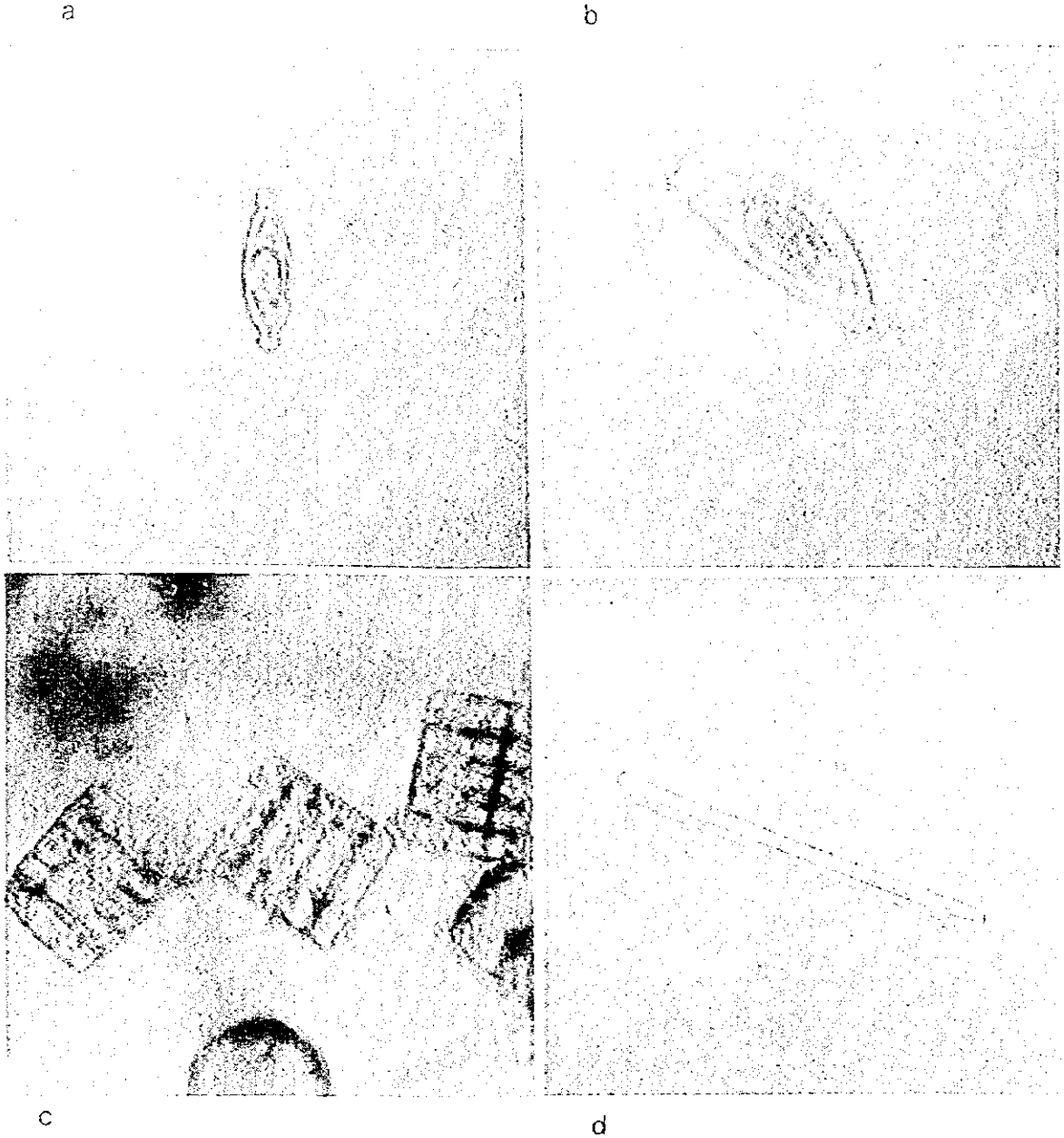

Figure 20. Some of periphyton commonly attached in the stones of the Brantas River. A. *Anomoeneis*, B. *Cymbella*, C *Tabellaria*, D. *Synedra*. (Photos: YR)

PLANT COMMUNITIES

The important of vegetation

Plants including all flora existed along the river have many ecological functions. Forest loss is the most serious threat to the habitats they occupy. Although many functions of plants, in general forest, aquatic plant and mangrove, have already been describe, it may be useful to summarize them here.

1. Dead leaf production to the surrounding bodies of water.

The continuous input of dead materials provides the basic of food chain in the environment. Many species are dependent directly or indirectly on these materials. The omnivore, herbivore fishes and some invertebrate feed directly on leaves which fall into the water. Plankton and macrophyte depend on nutrients such as nitrate and phosphate which is obtained indirectly from material organic decomposition.

2. Production of oxygen and carbondioxide fixation by aquatic plant.

Aquatic plants provide oxigen which is needed by all aquatic organismes for their respiration, contrarely, they fix carbondioxide which is dissolved in the water for their photosyntese process. During the night, aquatic plants do not photosynthesize and oxygen content can fall rapidly to a lesser level required by certain species. This can affect fishes mortality.

3. Reduction of temperature.

The rise in temperature is associated with decreased shading from vegetation. The higher temperature in the water, the greater metabolic rate of fishes and other aquatic animals, and the greater their demand for oxygen. Plant shadows can reduce the rise of water temperature.

4. Prevention of soil erosion.

Silt from poorly protected soil runs to river may cause soil erosion and may increase turbidity. This sedimentation will reduce the depth and will expand the width of the river, and for the later condition can smother eggs and spawning ground. The plant roots are useful for fixing river banks and for the prevention of soil erosion.

5. Feeding sites and nursery areas for aquatic animals.

Many aquatic species including fishes, shrimps and prawns depend on mangrove roots and aquatic plants as feeding sites and nursery areas.

6. Supporting the productivity and the diversity in aquatic environment.

Terrestrial forest and mangrove create habitat diversity in their environment. This will increase the productivity of the associated aquatic environment.

The existed species and the family composition

From the survey it has been collected 174 plant species along the Brantas River, including terrestrial plants, aquatic plants and mangrove species. The species, the relative abundance and the distribution are listed on annexes. These plants consist of 60

families (Table 14) which distribute along the Brantas river, and can be classified as mentioned below:

1. The highest number of taxa per family is Graminae which having 35 species.
2. Families which having taxa amount between 10 and 20 are Compositeae (16), Convolvulaceae (12), Cyperaceae (19), Leguminoceae (18), Malvaceae (15), Mimosaceae (10), Moraceae (10), Euphorbiaceae (14).
3. Families which having taxa amount between 3 and 9 are Acanthaceae (3), Amaranthaceae (9), Asclepiadaceae (4), Asteraceae (7), Bombaceae (5), Brasicaceae (3), Caricaceae (3), Componulaceae (4), Labiateae (5), Marsiliaceae (3), Musaceae (3), Myrtaceae (4), Onagraceae (4), Papilionaceae (4), Polypodiaceae (5), Rubiaceae (4), Salviniaceae (5), Solanaceae (4) and Verbenaceae (6).

   Families which only consist of 1 or 2 taxa are Annonaceae (1), Apoccynaceae (2), Araceae (2),Araliaceae (1), Avicenniaceae (2), Bignoniaceae (1, Boraginacea (2), Butomaceae (1), Caryophyllaceae (1), Casuariaceae (1), Comelinaceae (2), Cyatheae (1), Elaecarpaceae (2), Gleichenniaceae (1), Lannaceae (1), Marchantiaceae (1), Meliaceae (1), Nyctagenaceae (1), Oxalidaceae (2), Palmae (2), Passifloraceae (1), Pinnaceae (1), Polygonaceae (1), Polystrychaceae (2), Ponteridaceae (2), Portulacaceae (2), Rhizophoraceae (1), Rhomnaceae (1), Sapindaceae (2), Sellaginellaceae (1), Tiliaceae (1), Typhaceae (1).

Table 14. The plant family composition along the Brantas river.

Family	Higher altitude region	Middle region 1	Middle region 2	Delta region	Total of taxa per family
1. Acanthaceae				3	3
2. Amaranthaceae	2	2	2	3	9
3. Annonaceae			1		1
4. Apoccynaceae		1	1		2
5. Araceae			1	1	2
6. Araliaceae	1				1
7. Asclepiadaceae			2	2	4
8. Asteraceae	1	5	1		7
9. Avicenniaceae				2	2
10. Bignoniaceae				1	1
11. Bombaceae		1	2	2	5
12. Boraginaceae			1	1	2
13. Brasicaceae	1	1	1		3
14. Butomaceae				1	1
15. Caricaceae		1	1	1	3
16. Caryophyllaceae	1				1
17. Casuariaceae	1				1
18. Comelinaceae			1	1	2
19. Componulaceae		2	1	1	4
20. Compositeae	1	7	5	3	16
21. Convolvulaceae		3	5	4	12
22. Cyatheae	1				1
23. Cyperaceae	3	3	6	7	19
24. Elaecarpaceae			1	1	2
25. Euphorbiaceae		6	4	4	14
26. Gleichenniaceae	1				1
27. Gramineae	4	7	14	10	35
28. Labiatae		2	1	2	5
29. Lannaceae		1			1
30. Leguminoceae		5	8	5	18
31. Malvaceae		4	5	6	15
32. Marchantiaceae	1				1
33. Marsiliaceae		1	1	1	3
34. Meliaceae			1		1
35. Mimosaceae		3	4	3	10
36. Moraceae		3	5	2	10
37. Musaceae		1	1	1	3
38. Myrtaceae	2		1	1	4
39. Nyctagenaceae		1			1
40. Onagraceae	1	1	1	1	4
41. Oxalidaceae	2				2
42. Palmae			1	1	2
43. Palystrychaceae	2				2
44. Papilionaceae		1	2	1	4
45. Passifloraceae				1	1
46. Pinaceae	1				1
47. Polygonaceae			1		1
48. Polypodiaceae	2	3			5
49. Ponteridaceae			1	1	2
50. Portulacaceae			1	1	2

51.Rhizophoraceae				1	1
52.Rhomnaceae				1	1
53.Rubiaceae		1	2	1	4
54.Salviniaceae		1	2	2	5
55.Sapindaceae			2		2
56.Selaginellaceae	1			1	2
57.Solanaceae	1	2	1		4
58.Tiliaceae		1			1
59.Typhaceae				1	1
60.Verbenaceae	1	1	2	2	6

Higher altitude: Sumber Brantas - Junggo
Middle region 1: Sengkaling - Sengguruh
Middle region 2: Sengguruh - Mojokerto/Lengkong
Lower region : Surabaya & Porong river - estuaries

Zonation of Macrophyte along the Brantas river

Macrophyte communities appear to be governed by climate, geology and soil type and low or high altitude stream, thus, different specific zones will have specific macrophytic vegetation. The distribution of macrophyte along the Brantas River can be classified based on the different habitat of the macrophyte as mentioned below.

- **Terrestrial plants (excluding Mangrove)**

Terrestrial plants which only inhabit in very high altitude such as at Sumber Brantas and Junggo and which are not found in the other region are Celosia argentea, Cemara, Cyathea sp, Cyperus brevivolius, Datura metel, Drymaria cordata, Eucalyptus alba, Eugenia cumini, Gleichenia sp., Lantana camara, Nephrolepis cordifolia, Nothopanax quincifolia, Osmunda sp, Oxalis acetofolia, Oxalis carniculata, Polystrichum commune, Pinus merkusii, and Selaginella sp.,

Terrestrial plants only inhabit in the lower part of the Brantas river from Surabaya river to the river mouth such as Abutilon indicum, Claris barbata, Delonix regia, Dolichandron spathacea, Enterolobium saman, Fimbristylis, Passiflora paetida,

Phaseolus fulgaris, Phyllanthus reticulatus, Pithecellobium dulce, Portulaca sp, Ricinus communis, and Zizyphus mauritania.

Other mcrophytes, as can be seen in the annexe, grow sparsely or abudantly between upper and lower part of the Brantas river. These species may have a wide or a narrow distribution.

- **Aquatic Plants**

Marchantia polymorpha from the Family of Marchantiaceae is the only aquatic plant which is found in the upperstream part of the Brantas River.

Aquatic plant such as *Cyperus pilosus, Limnocharis flava* (rare), *Marsilia aquatica* (many) and *Typha angustipholia* grows in the lower part of the river from Surabaya river to the river mouth.

The others inhabit and distribute widely along the Brantas River. These species include *Ipomoea aquatica*, Salviniaceae and their derived, *Marsilia crenata, Eichhornia crassipes, Jussiena repens*, and *Spenoclea zeylanica*

- **Mangroves**

The mangrove forest often exhibit a very complex zonation pattern. Many studies of zonation schemes or pattern have been done by some authors. The schemes is generaly based on the existed frequency, or on the dominant species.

Mangrove refers to complex of plant communities fringing sheltered shores. In the Brantas Delta this communities occupy the riverine area of the estuary, coastal area and pond areas. At least there are 8 mangrove species in the Brantas delta which are dominated by *Avicenia marina, Avicenia officinalis, Acanthus ilicifolius* and *Exoecaria agallocha*. Other species such as *Nypha*

fructicans and *Xylocarpus sp*, distribute moderately. *Rhizophora* and *Derris sp*. are found rarely.

The zonation pattern among these species shows heterogen, it means that there is no specific pattern which is separated by ecological characteristic such as tide and soil-water salinity. Mangrove plants are associate together with epiphytes, few lianes, grasses and other higher plants.

This pattern is not the same with other mangrove forest located in other area in East Java like in Curah Sawo, which is dominated by Rhizopora and showing zonation of certain species. In the Brantas delta, water salinity is very high, especially in many ponds which can reach more than 40 promil. This reason indirectly makes specific communities of mangrove species which is shown by the abundance of Avicenia. These plants are dominant in the Brantas delta because of their high adaptation to environment such as salinity and partly anaerobic soil.

Indicator species

Macrophytes have some important advantages as indicator species: they are stationary and visible to the naked eye. Until relatively present their responses to pollutants were not well documented, but attempts have now been made to provide schemes for assessing environmental damage (Harding, 1981; Haslam, 1982; *in* Hellawell, 1986).

A

B

Figure 21. Some of mangrove species which inhabit in many quantity at the Brantas delta. A. The sapling of *Acanthus*; B. *Exoecaria*.

Until present, the study concerning the use of terrestrial plant for ecological indicator is very lack, but many studies have been done for the use of aquatic plants as indicator of water quality. Water hyacinth, *Eichhornia crassipes* is known can accumulate some pollutants such as cadmium, lead, mercury (Chigbo *et al*, 1982), and detergent (Akhyaar, 1996). Thus, this aquatic plant can be recomended as an indicator species for water quality.

Other species can also be considered as pollutant indicator based on their habitat in the Brantas river, they are *Cyperus pilosus, Marsilia aquatica* and *Typha angustipfolia* which are found in many quantity from Surabaya river to the river mouth. The only species inhabit in Sumber Brantas or Junggo, *Marchantia polymorpha,* may be considered as indicator of clean water. Further study concerning the use of macrohyte as indicator of water quality is needed to understand their physiological characteristic of pollutant accumulation and to manage river environment.

Mangrove and fisheries in the Brantas delta

The important of mangrove in providing nutrient for aquatic animal and as nursery areas has long time been recognized. A variety of fish species and herbivorous animal feed in the mangrove forests.

In relation to their function as a nursery area for many species, mangrove has a role in supporting prawn migration for the completion of its life cycle. Knox *et al.*, (1984) stated that the freswater prawn, *Macrobrachium*, is dependent on the brackish-water environtment. Pregnant female migrate from freshwater rivers and lakes to the mangrove swamps along the coasts, where the eggs hatch into free swmming larvae. After completion of the pelagic larval stage, the larvae metamorphose to a benthic stage and crawl back upstream to fresh water. On the other hand, marine species spawn in

the shore, the newly larvae migrate to the mangrove swamps and stay until they reach the juvenil stage then migrate offshore.

Mangrove in the Brantas delta, especially in Wonokromo river, facing some problems.

1. Mangrove conversion to other land uses.
Mangrove area has been changed to aquaculture ponds or tambak since 1962. There are approximately 200 hectars of tambak which are managed traditionaly for milk-fish and shrimp culture (Yazid and Amar, personnel communication). In the future, the area will be converted to a settlement area.

2. Mangrove cutting.
Mangrove forests are exploited by local people for a source of firewood. Ohter reason, some local people cut the old trees as a preventive action from pest and desease.

3. Lacking of silvofishery management.
Based on the survey on the last of November 1997, the most pond areas has very high salinity (38-42 promil). It is the fact that Wonorejo area has no fresh water resources, it is only from the rainfall during the rainy season the ponds obtain the freshwater. On this condition, Penaeus and adult milk fishes (more than 2 kg of weight) die, only white shrimps and the juveniles adapted in these ponds.

The Problems and the solutions

1. Aquatic plant problem.

It has been long time known that the Brantas River facing problem of water hyacinth, *Eichornia crassipes* (Eceng Gondok). This aquatic plant grows and covers surface water of river and reservoirs rapidly. Commonly it inhabit densely in stagnant water or in slugish flowing water. Our observation shows that the plants cover about 25 percent of river area at Porong in the dry season (August 1997) and in November the river had been covered by almost 100 percent of the surface area.

2. Forest loss is the most serious threat to the habitat they occupy. This include forest conversion to other land uses, cutting of trees, etc.

3. The aquatic plants can be used as water quality indicator and they have many functions for aquatic animals. The uncontrolable of sand and stone mining can vanish aquatic plants, which then influence biodiversity.

Solutions for these problems can be proposed:

1. Cleaning water hyacinth by machines, chemist or others such as by prevention of direct sunlight. Local people and NGO can also be involved to clean this plant. Monitoring is needed to control their growth.

2. Forest loss due to conversion to other land uses such as aquaculture ponds can not be avoided. On the other hand the multiple use system of pond and mangrove can be applied. This system is called "tambak tumpang sari" (Sukardjo, 1988) or

"silvofishery" (Anonyme, 1997) because it embraces multiple land use practice involving joint production of mangrove forestry and fishery crops. This concept may provide traditional fishery products and may save the existing mangroves.

3. Giving information and guidance to the people or inhabitants near the forest sites. Involving LKMD, LSM, local people to support reforestation.

4. Increasing the supervision of forest and excecuting law enforcement.

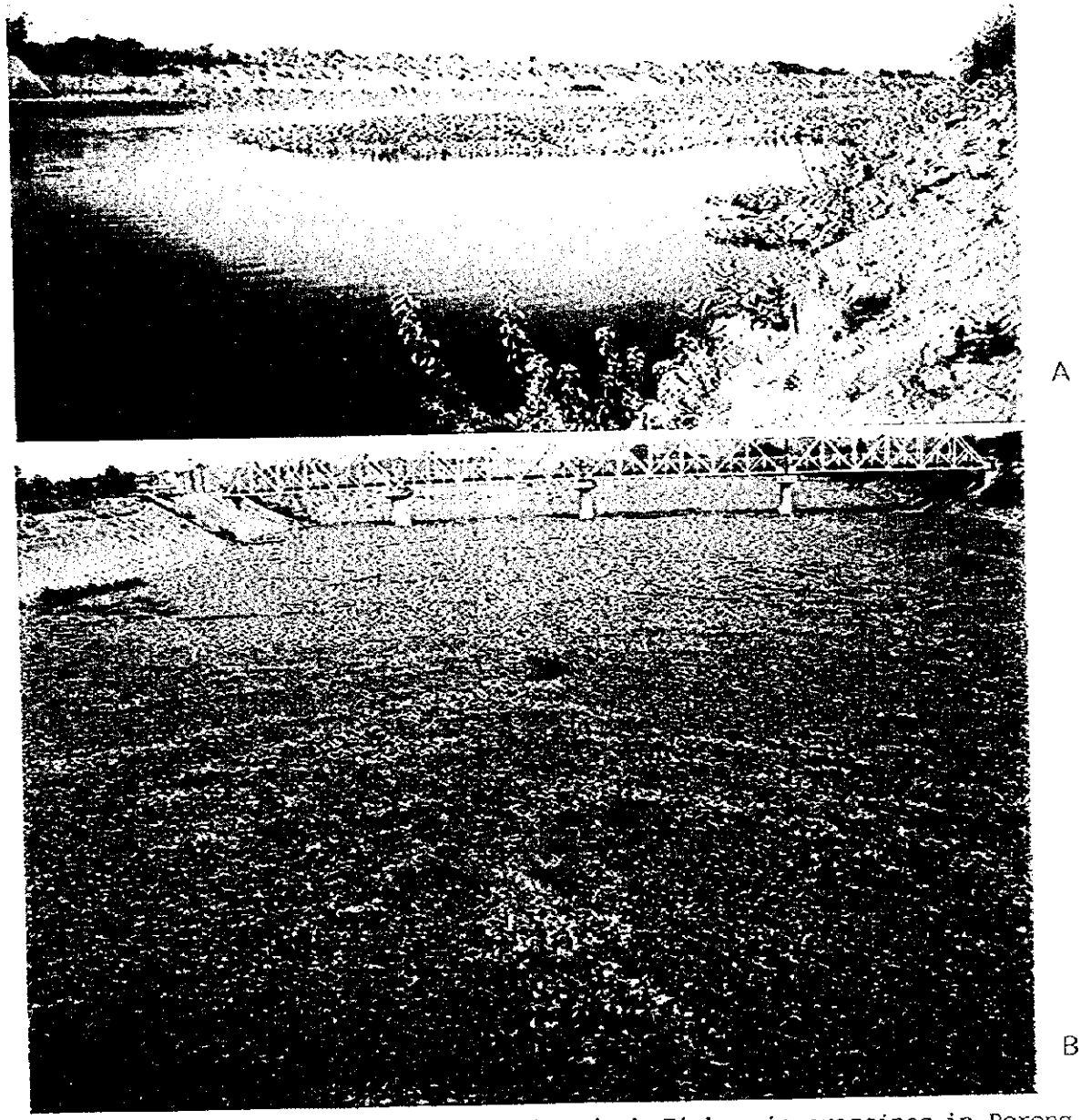

Figure 22. Aquatic plant, the water hyacinth *Eichornia crassipes* in Porong during the dry season, August 1997 (A). The species covers approximately 100 % of the total area in the beginning of the rainy season December 1997 (B). (Photos: SS & YR).

OTHER FAUNA

Although this observation is not focused for the terrestrial animals, some terrestrial animals which were found coincidentally during the survey of the Brantas River in 1997 were taken also into the note.

Some other terrestrial fauna were found during the survey in 1997 commonly consist of some livestocks from a small-scale animal husbandries or from local people inhabit in the Brantas River. Some aquatic birds such as ducks and gooses are found in Malang Regency. Some poultries such as free-range chickens are also found in the river banks, especially in the sites which have a dense population. These animals were raised by the local people. Some goats and sheeps were raised in the area where many graminae grows in an important quantity in the river banks.

Some wild animals were found coincidentally in the delta of the Brantas river. The wild animals exist here are some wild monkeys which hid on mangrove area near the Brackish-water fishery ponds.

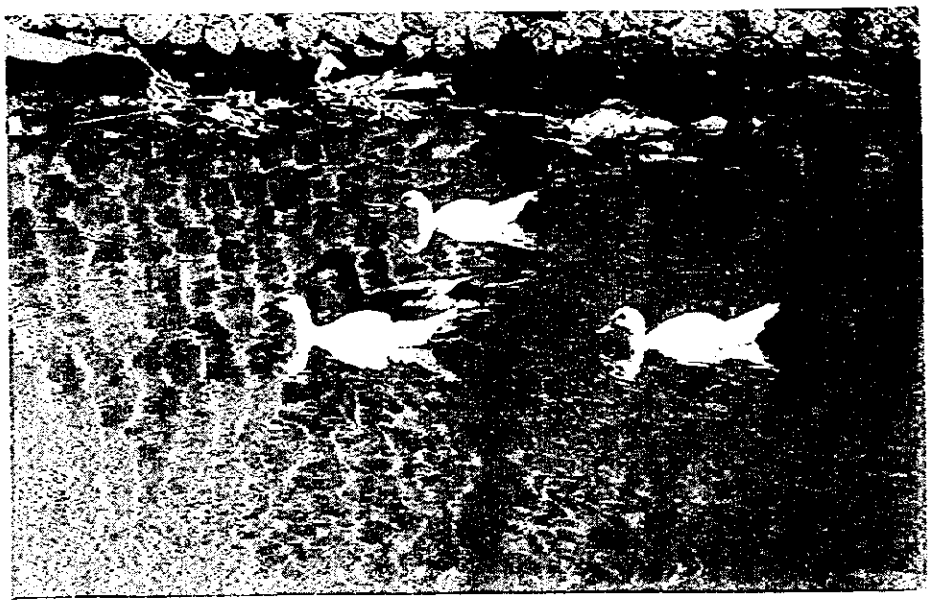

Figure 23. Some aquatic birds of the Brantas river.

GENERAL CONCLUSION

The Brantas river has a very important role as water resources for agraricultural demand, domestic, industries and many other functions. Based on ecological data, especially dissolved oxygen and BOD, the water quality of the Brantas River has a range from clean to dirty water. These ecological factors appear to restrict the spatial distribution of biological communities.

The result of the dry and the rainy seasons survey of Biological diversity of the Brantas river reveals that the river has an abundance of species and the richness of species illustrates the importance of river biodiversity. It has been found approximately 50 fishes species from the river, among of them 18 species are indigenous fishes of the Brantas river. This observation shows that the amount of indigenous species decrease approximately to less than 30 % of the total species in 1962. The decrease of indigenous fishes are caused by the decrase of biodiversity of vegetation and other plant communities as primary producers in the lower food chains. These are also caused by the change of habitat or others as shown in the Fig. 24.

Fish distribution pattern shows a higher number of species in the middle part of the Brantas river between the three big reservoirs in Sengguruh, Ngembul and Kademangan. It can be concluded that reservoirs or dams may be a good habitat for fishes but it may limit the behavior of their movement. Because fishes tend to migrate from a place to another place for spawning, breeding and for feeding, so, dams building without fishes passage may change living behavior of potamodromous fishes (fishes inhabit in running water) become lacustrine fishes. The higher diversity is shown also in Ngunut and Papar but tend to decrease in the lower part. The lower diversity is influenced by water pollution

especially in Surabaya Regency, and only some tolerance species inhabit here.

From this study, it can be classiifed some indicator fishes based on their presence in clean or polluted water. *Cyprinus*, *Nemacheilus* and *bekepek* are clean water species; other species such as *Suckermouth*, *Clarias*, *Mystus micracanthus*, *A. panchax*, *Poecilia*, *Tilapia* and *M. albus* are polluted water species.

Pangasius macronemus or wakal is popular in the Brantas river, this is the keystone species. Other species such as *M. aculeathus*, *I. carce*, *seren*, *areng-areng*, *blancer* and *sengkaring* are found rarely. While the endemic species in the middle part are *.N. fasciatus*, *K. lawak*, *L. siamensis*, and *G. platypogon*. Many other species in the Brantas river have economic and ecological important roles.

Macroinvertebrate communities have an important role as energy transfer in the food chains, in self purification and as a good indicator to monitor water quality. The observation reveals that macroinvertebrate communities have a higher taxa amount from the upperstream to the middle part of the Brantas river, either in the dry and in the rainy season.

Macroinvertebrates are immobile and have a long life cycle, so their presence in the stream may reflect their environment. Some different groups from the Brantas river have been identified as indicator species: member of Plecoptera are sensitive to pollution, member of Hydropsychidae are moderate group and Tubificidae derived from Oligochaeta are tollerant to water pollution. This is shown by different communities inhabits from the upperstream to the lowerstream. Tubificidae are abundant in Surabaya river to the estuary where many pollutions occur here.

Plankton show a domination of one species in some area. During the dry season Karangkates is dominated by Chorhormidium (87%) and other species, Oscillatoria is dominant in Lengkong

reservoir (80%) and in Wonokromo (71%), while Spirulina shows abundant in Surabaya river (71,5%). In the beginning of the rainy season the communities changes in the reservoirs, it means that there is no domination of a species. The domination of species only occurs in sluggish-flowing water as shown by Microcystis (72%) in Surabaya river.

Domination of Periphyton are shown by Tabellaria (70%) at Ngunut during the dry season and Ulothrix (72%) at Sengkaling in early of rainy season.

The domination of a species is related to diversity value (index) and in general indicate a lower diversity. Plankton are applicable to estimate the environmental condition in stagnant water, and periphyton are usable for running water. Based on diversity index, Sumber Brantas and Junggo have a higher diversity which indicate a good environmental condition, and in contrast the lower value has reached to the upperstream part such as in Sengkaling and Malang. This is due to nutrient enrichment i.e. nitrate, which is high in these sites, and it also has been polluted by organic materials which dissolved into the water.

Plants existed along the Brantas river have many ecological functions such as: dead leaves production which provides the basic of food chains in the environment, production of oxygen and carbondioxyde fixation, reduction of temperature, prevention of soil erosion, feeding sites and nursery areas for aquatic animals and these may support the productivity and the diversity in aquatic environment. Plant vegetation which has been sampled from upper to lower Brantas indicates a great variability of species along the river. From the survey has been collected 174 species of 60 families, including terrestrial plants, aquatic plants and some mangrove species. Some terrestrial plants have a different zone from only inhabit in a very high altitude to species of the lower altitude.

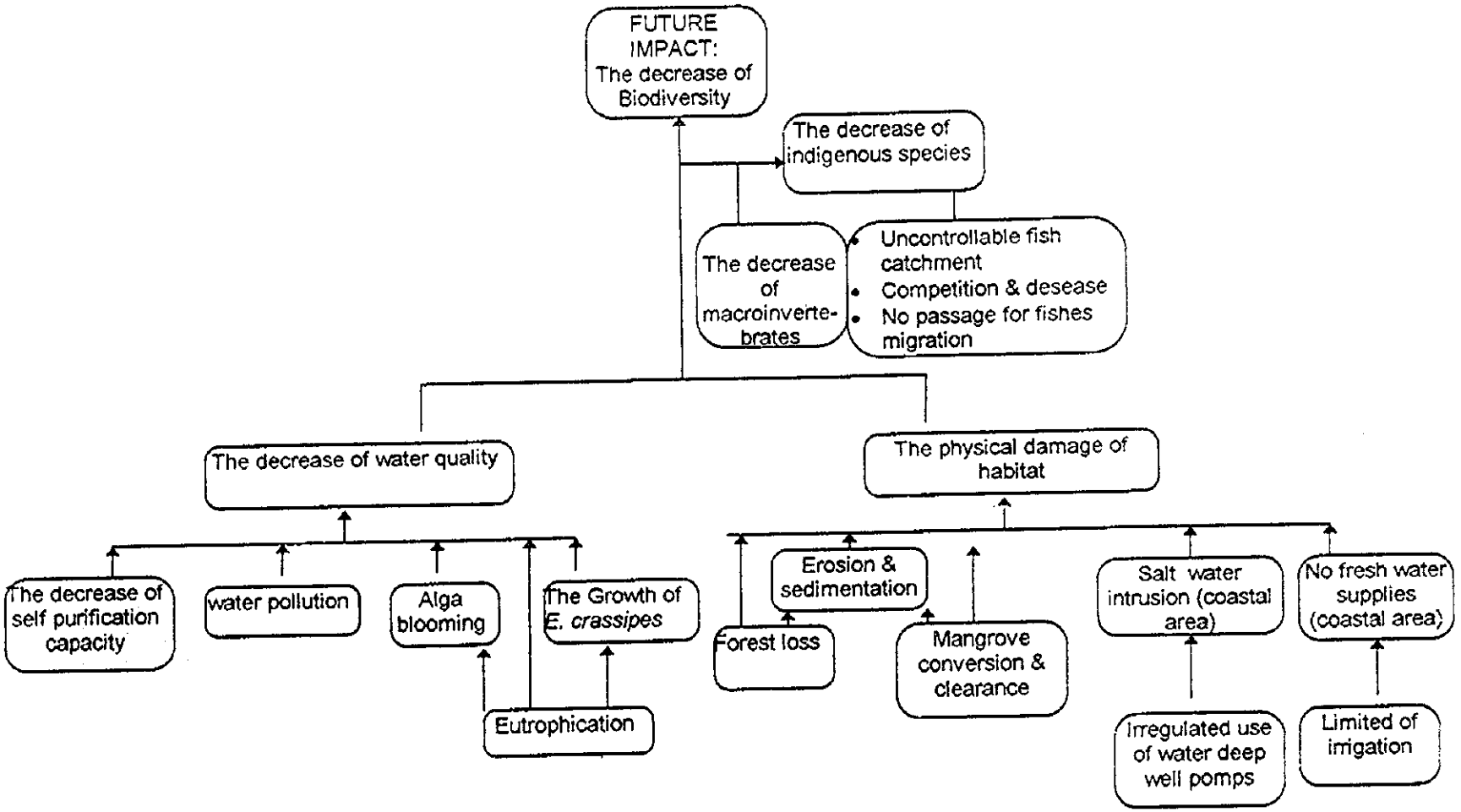

Fig. 24. The interrelated problems of the Brantas river in the connection with biological diversity.

Mangrove only inhabit in the lower part of the Brantas river. In the Brantas Delta this communities occupy the riverine area of the estuary, coastal area and pond areas. At least there are 8 mangrove species in the Brantas delta which are dominated by *Avicenia marina, Avicenia officinalis, Acanthus ilicifolius* and *Exoecaria agallocha*. Other species such as *Nypha fructicans* and *Xylocarpus sp*, distribute moderately. *Rhizophora* and *Derris sp*. are very rare.

Macrophytes have some advantages as indicator species because they are immobile and visible to the naked eye. Water hyacinth, *E. crassipes* can accumulate some pollutants, so, this aquatic plant can be recomended as pollutant indicator. Other species are good for pollutant indicator such as *Cyperus pilosus, Marsilia aquatica* and *Typha angustifolia*. The indicator of clean water is *Marchantia polymorpha*. Further study of macrophyte as indicator for water quality is needed to know their physiological pollutant accumulator and to manage the river environment.

Biodiversity in the Brantas river is very important to be conserved but the river facing some problems in relation to the issue of biodiversity. The interelated problems of the Brantas river can be seen on the Fig. 24; which shows that the negative aspects of each "branch" may bring other problem in the future such as the lowness of biological diversity. These problems which indicated by negative (-) ecological impact can be formulated in present feature with the action should be taken or program listed on the fourth collumn, for a better condition in the future, as shown on this scheme. On the other hand, the positive impact (+) of the present feature should be maintained or developped for the sake of natural conservation. The general target should be reached in the connection of this subject is a higher biological diversity in the Brantas river.

Aspect	Present feature	impact	program
Biodiversity (general)	Water pollution	-	• Improvement of waste water treatment for domestic and industrial waste • Monitoring habitat & law enforcement • Cooperation with industry in waste treatment management
	Sedimentation	-	• Sand digging monitoring & law regulation
Fish communities	Higher diversity in the middle part	+	• Decide priority area (in the middle part) for biodiversity conservation,
	Dams construction without fishes passages	-	• Create a mini renovation of fish passage at dams for fishes migration
	Decrease of indigenous species	-	• Habitat improvement • Culture assay of indigenous fishes, especially endangered species • Fish cathcment monitoring • Decreasing pollutant source
	Reservoirs function not for fish culture yet	-	• Recomendation of floating net fish culture or "karamba" system • TOR for fishery management
	Lack of information of fish ecological characteristic & their behaviour	-	• Research recomendation
Macroinverte-brate communities	the change of substratum due to the removing of sand, stone, gravel	-	• Controlling sand digging and improvement of habitat
	higher diversity in the upperstream to the middle area (means higher variety of fish "food")	+	• Conservation of habitat in the related area
	lower diversity in the downstream part	-	• Decreasing of pollutant source regularly

Planktonic communities	higher diversity, stabil, higher variety of fish food,	+	• Conservation of habitat in the related area
	lower diversity, domination of a species or algal blooming	-	• Create a better water quality management
Plants communities	Forest loss	-	• Forest supervision • Law enforcement
	Mangrove cutting	-	• idem
	Mangrove conversion to other land use	-	• Strategy of multy-used system, i.e. tambak tumpang sari/silvofishery, etc. • Regulation and TOR
	Lack of silvofishery management	-	• Guidance to the local people, cooperation with other related institutions
	Disturbance of *E. crassipes* in the slow flowing/stagnant water	-	• Cleaning *E. crassipes*, Monitoring their growth
	Increase of CO_2 in the water by the aquatic plant during the night	-	• Water quality management & Airation
	Reduction of macrophyte caused by uncontrollable sand mining.	-	• Supervising of sand mining & law enforcement

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ANNEXES

Annex 1. Dissolved Oxygen, BOD_5, Nitrate, Phosphate and pH.

rainy season 1997

Region	No	Sampling site	DO mg/l	BOD_5 mg/l	NO^{3-} (mg/l)	PO^{4-} (mg/l)	pH
Upper	1	*Sumber Brantas*	5.45	2.69	1	0.23	5.0
	2	*Junggo*	8.29	2.75	4	0.25	5.5
	3	*Sengkaling*	10.56	5.24	7	0.79	6.5
	4	*Malang*	7.07	4.22	7	1.03	6.0
	5	*Sengguruh Res.*	5.37	2.93	2	0.35	7.0
	6	*Karangkates reservoir*	2.9	2.33	2	0	6.8
Middle	7	*Kademangan*	8.14	5.99	5	0.37	6.6
	8	Ngunut	6.83	5.83	3	0.06	6.5
	9	*Papar*	6.3	4.6	2	0.08	6.5
	10	*Ploso*	6.5	0.32	3	0.21	6.0
	11	*Padangan*	7.48	7.09	2	0.28	6.5
Lower	12	*Lengkong*			-	-	
	13	*Porong*	2.09	6.09	nd	nd	nd
	14	*Porong Estuary*	1.71	8.1	3	0.42	6.5
	15	*Canggu*	6.08	6.59	2	0.23	6.5
	16	*Petekan*	1.33	6.57	1	1.24	6.3
	17	*Gunungsari (Surabaya river)*	2.28	6.83	3	0.31	6.0
	18	*Hulu Wonokromo*	-	-	1	1.06	6.2
	19	*Wonokromo Estuary*	-	-	2	0.76	6.0

Dry season 1997.

Region	No	Sampling Site	DO mg/l	BOD_5 mg/l	NO^{3-}	PO^{4-} (mg/l)	pH
Upper	1	*Sumber Brantas*	7.6	2.8	23 mmol/m^3	0.6	9.0
	2	*Junggo*	8.1	2.75	6 mg/l	0.8	9.0
	3	*Sengkaling*	7.8	3.55	12 mg/l	1.7	6.5
	4	*Malang*	8.4	3.20	7 mg/l	4.3	6.0
	5	*Sengguruh*	6.76	1.92	17 mmol/m^3	1.0	6.5
	6	*Karangkates reservoir*	-	3.70	5 mg/l	0.3	
Middle	7	*Kademangan*	7.43	5.96	33 mmol/m^3	0.3	6.5
	8	Ngunut					
	9	*Papar*	9.12	4.60	3 mg/l	2.14	6.5
	10	*Ploso*	8.31	0.90	2 mg/l	0.25	
	11	*Padangan*	4.28	12.96	2 mg/l	0.33	7.0
Lower	12	*Lengkong*	2.23	7.16	1 mg/l	0.46	6.5
	13	*Porong river*	-	6.90	17 mmol/m^3	0.65	6.5
	14	*Porong Estuary*	2.64	12.20	1 mg/l	0.69	
	15	*Canggu*	6.42	5.62	2 mg/l	0.27	7.5
	16	*Petekan*	2.57	7.90	2 mg/l	0.62	
	17	*Gunungsari (Surabaya river)*	3.38	5.40	1 mg/l	0.33	
	18	*Hulu Wonokromo*	3.31	6.40	1 mg/l	0.4	
	19	*Wonokromo Estuary*	6.89	4.90	3 mg/l	0.71	6.5

Annexe 2a : The abundance of Macroinvertebrate of the Brantas River during the dry season in 1997.

Macroinvertebrate	Sampling site												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Ariidae								5					
Atydae					1								
Baetis sp 1		56			1			3					
Branhiura sp				10					4	6	10		
Brotia sp			19					124					
Caenis sp							10						
Centroptilum			74					42	44	64			
Chaeborus			3										
Chironomidae	193	48	32	330	77	1	97	15	14	5			
Chironomus thummi			6	15	2		1						
Chouborus			3										
Coleoptera sp 1							12						
Corithidae cingulata												2	
Corixidae sp 1					25		84						68
Corixidae sp 2							89						
Crab	1		1		1							1	
Dicranota sp 1			17				4						
Diptera sp 16			16										
Dixa sp	2				10		31						
Dytistidae							25						
Ecdyonurus sp						95							
Gyrinus sp.									15				
Halipidae		2											
Heptogenia							1						
Hydrophilidae						5							
Hydropsyche angustipennis		168	117	33		106	5						
Lepidoptera sp 1						1							
Lepidostomatidae			19										
Limnaea sp1			176										4
Limnaea sp2			240				12						
Lymnea columella			1				1						
Melanoides granifera								51	9	3		1	
Melanoides tuberculata								10	3	15		1	
Melanoides rustica							2	1					
Mesovelidae													13
Micronectinae													1
Naididae										1	108		
Pedicia sp							23						
Philopotamidae							16						
Physa fontinalis		2											1
Planaria	15	97											
Planorbidae			1										
Procloen sp		99	9				8						
Psychomyiidae									2				

Rhapidolabis				1			-						
Sericostomatidae						2							
Simulium	80	55	13										
Sipholonuridae									4				
Sphaeriidae							11		4				
Sphaerium							69	1	5				
Syncera javana								32					
Syrphidae						1							
Tipulidae		12	15				38	2					
Tipula sp1	1												
Tipula sp2	2												
Thiaridae sp1									73				
Thiaridae sp2									19				
Tubificidae				25					1	7	895		

1. Sumber Brantas; 2. Junggo; 3. Sengkaling; 4. Malang; 5. Sengguruh; 6. Kademangan; 7. Papar; 8. Ploso; 9. Canggu, 10. Gunung Sari 11. Petekan 12. Wonokromo estuary; 13. Porong.

Annexe 2b : The abundance of Macroinvertebrate of Brantas river during the rainy season in 1997.

Macroinvertebrate	Sampling site												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Anentoma helena					4								
Baetis spl	115	360	20			162							
Bellamya javanica											11		
Branchiura													2
Brotia spadicea											4		3
Brotia testudinaria spp.2										9			
Bulimidae			15										
Caenis sp.						1		20	13				
Centroptilum			28				187						
Ceratopogonidae		10											
Chimarra sp.								1	8				
Chironomidae	267	347	10			2		2	10				
Chironomus thummi				14							1	6	
Coenagriidae					1								
Coleoptera spp.5							2						
Crab			1										
Dysticidae						1							
Dixa sp						1	7						
Gyrinus		10											
Glossiphonidae sp.1			3										
Glossiphonidae sp.2					3								
Heptogenia			1			120							
Hydropsyche angustipenis		256	12			24			4				
Ilybus sp.	2	3											
Lepidoptera sp.7			5			8			7				
Lepidostomatidae	21	76	34			5							
Lumbriculidae			5	10								55	
Lymnaea sp.							1						
Melanoides sp.					1								
Melanoides javanica											6		
Melanoides tuberculata												1	1
Naididae			1								1	3	
Physa fontinalis											1	1	
Planaria	57	121	4										
Platambus	47												
Procloeon sp.		25						43	6				
Prosobranchiata spl	1		15										
Prosopristoma									1				
Psichodidae	1			2									
Rhithrogenia						1							
Seriscotomatidae	1												
Simulium sp.	138	360											
Spaniotoma	27	24	2	13					3				

Sphaeridae									1				
Sphaerium						4	1	2	2				
Stratiomyiidae	1												
Syncera javana spp. 1			7			14			5				
Syncera javana spp. 2			20										
Telmatoscorpus				4									
Thiara scabra			1								2		
Tipula sp				2									
Tipulidae (Antocha)	20		1			1							
Tubificidae				29						437	609		

1. Brantas source; 2. Junggo; 3. Sengkaling; 4. Malang; 5. Karangkates; 6. Kademangan; 7. Papar; 8. Ploso; 9. Canggu, 10. Gunung Sari; 11. Petekan; 12. Wonokromo river; 13. Porong.

Annex 3a : Plant species identified from sampling sites of the Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	*Abutilon indicum Sw*	Malvaceae	Cemplak																	b				
2	*Acalypha indica*	Euphorbiaceae				b	b																	
3	*Acalypha marginata Hart*	Euphorbiaceae											b											
4	*Acalypha wilkesiana MA.*	Euphorbiaceae					b																	
5	*Acanthus ilicifolius*	Acanthaceae	Daruyu																	e	e		d	c
6	*Acasia*	Leguminoceae	Orak-arik					b																
7	*Achiranthes aspera L.*	Amaranthaceae	Jarong				b												b		d			
8	*Adiantum*	Polypodiaceae	Suplir			d	b																	
9	*Ageratum conizoides L.*	Composiae	Wedusan			c			b	d	b	b	b	b	b				b					
10	*Albisia falcata Back*	Mimosaceae	Sengen laut					b	d															
11	*Alysicorpus vaginalis DC.*	Leguminnaceae	Brobos			b																		
12	*Amaranthus sp.*	Amaranthaceae	Bayam			b																		
13	*Amaranthus spinosus*	Amaranthaceae	Bayam duri						b	b	b					b	b	b	b					
14	*Amarantus tricolor L.*	Amaranthaceae	Bayam		b						b								b					
15	*Andropagon nardus*	Gramineae	Sere								c													
16	*Annona muricata L.*	Annonaceae	Nangka sabrang					a	b															
17	*Arachis hypogaea L.*	Leguminoceae	Kacang tanah						d															
18	*Artocarpus*	Moraceae	Nangka					b																
19	*Artocarpus communis*	Malvaceae	Kluwih			b		a	b									a		c				
20	*Artocarpus heterophylla Lamk*	Moraceae	Nangka				b				b													
21	*Avicenia marina L.*	Avicenniaceae	Api-api																	e	e		d	d
22	*Avicenia officinalis L.*	Avicenniaceae	Api-api																	e	e		d	d

Note :
1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.
a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3b : Plant species identified from sampling sites of the Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
23	*Bambusa arndinaceae (RETZ) Willd*	Gramineae	Bambu ori			e								c										
24	*Bambusa sp.*	Gramineae	Bambu apus		b			d		d	d						b							
25	*Bambusa spinosa*	Gramineae	Bambu ori								d													
26	*Bidens pilosus L*	Asteraceae	Ajeran			d																		
27	*Bougenvillea spectabilis Willd*	Nyctagenaceae	Bugenvil			b																		
28	*Brasica sp.*	Brasicaceae								b														
29	*Calocasia sp.*	Araceae	Talas						d									d						
30	*Calotropis gigantea*	Asclepiadaceae													b									
31	*Calotropis gigantea Burn*	Asclepiadaceae									c	a		b										
32	*Calotropis gigantea Dryent*	Asclepiadaceae	Biduri										c			b			c			e	b	
33	*Capsicum frutescens L.*	Rubiaceae	Lombok									c												
34	*Carica papaya L.*	Caricaceae	Pepaya				b	b	b		b											b		
35	*Cassia siamea Lamk*	Leguminoceae	Johar							b	b													
36	*Cassia sp*	Leguminnaceae				b																		
37	*Cassita filiformis*	Lannaceae	Tali putri				c																	
38	*Cuba petandra . Gaertn*	Bombaceae	Randu				a	b	b	b												b		
39	*Cuba petandra L.*	Bombaceae	Randu								b						b							
40	*Celosia argentea L*	Amaranthaceae	Baroco		c																			
41	*Cemara*	Casuariaceae	Cemara	b	b																			

Note :

1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.

a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3c : Plant species identified from sampling sites of the Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
42	*Chloris barbata Swartz*	Gramineae	Rumput kembang goyang							d												b		
43	*Claris barbata*	Gramineae														b								
44	*Clitoria ternatea*	Leguminnaceae	Empik-empikan			b						a												
45	*Clotalaria striaca DC.*	Papilionaceae	Orok-orok								b													
46	*Cocos nucifera L.*	Palmae	Kelapa					d	b															
47	*Commelina nudiflora*	Comelinaceae	Geworan							b		b			a									
48	*Crotalaria striaca DC*	Leguminoceae				c						a							b					
49	*Cyathea sp.*	Cyatheaceae	Paku tiyang		a																			
50	*Cynodon dactylon*	Gramineae	Rumput grinting			d	d		d			e	d	e		d		d	d		d			
51	*Cyperus brevifolius (Rottb) Hassk.*	Cyperaceae	Teki	b																				
52	*Cyperus compressus*	Cyperaceae								c														
53	*Cyperus diformis*	Cyperaceae	Teki sawah							b	b								c					
54	*Cyperus distan L.*	Cyperaceae			a																			
55	*Cyperus flabelliforms*	Cyperaceae				e	c												b					
56	*Cyperus iria L.*	Cyperaceae	Teki		b	c				c	d			e					c					
57	*Cyperus pilosus*	Cyperaceae																b	c					
58	*Cyperus rotundus L.*	Cyperaceae	Teki				b				b	e			e				b					

Note :
1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.

a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3d : Plant species identified from sampling sites of the Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
59	*Cyperus sp.*	Cyperaceae	Teki										d						b	b	b			
60	*Datura metel L.*	Solanaceae	Kecubung	b													b							
61	*Delonix regia*	Leguminoceae	Flamboyan																				d	
62	*Dolichandrone spathacea (L.F) sch*	Bignoniaceae	Ki Jaran																					
63	*Drymaria cordata (L) Wield exr&s*	Caryophylla-ceae	Jukut Ibun	c	d																			
64	*Eichhornia crassipes (Mart) Solms*	Ponteridaceae	Enceng gondok						d	c			c		c	c	c	a	d	d				
65	*Eleusine indica (L) Gaerth*	Gramineae	Rumput lulang		b				c	d	d	d	e	d		d	b	b	d					
66	*Emilia sonchufolia (L)*	Asteraceae	Patah kemudi				d																	
67	*Enterolobium saman Prair*		Trembesi															a						
68	*Eragrostis amabalis*	Gramineae	Emprit-empritan				d		d	d	d		c	c		d								
69	*Erechtites valerianifolia (Walf) DC*	Asteraceae				b																		
70	*Erytrina variegata L.*	Papilionaceae	Dadap			b																		
71	*Eucalyptus alba Reinus*	Myrtaceae		b																				
72	*Eugenia cumini Druce*	Myrtaceae	Duwet	b																				
73	*Eupatorium odoratum L.*	Compositae	Ki Pahit	c	c			b																
74	*Euphorbia geniculata*	Euphorbiaceae	Katemas			b																		
75	*Euphorbia hirta*	Euphorbiaceae	Patikan			b	d			b			c						d					
76	*Excocaria agallocha L.*	Acanthaceae	Kayu Wuto																	e	e		d	c

1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.

a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3e : Plant species identified from several sampling sites of Brantas river.

No	Species Name	Familia	Local Name	Sampling Sites																			
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
77	*Ficus benyamina*	Moraceae	Beringin								a						a							
78	*Ficus septica*	Moraceae	Awar-awar				a				b													
79	*Ficus septica Burn*	Moraceae	Awar-awar					b	b		b					b								
80	*Ficus sp.*	Moraceae	Awar-awar			b																		
81	*Filicium desipiens Thw*	Sapindaceae						b													d	d		
82	*Fimbristylis*	*Cyperacea*	Mendong							c		b		b					d				d	
83	*Fimbristylis annua R & S*	*Cyperaceae/ Gramineae*	Bulu Mata Munding																					
84	*Gleichenia sp.*	Gleicheniaceae	Paku garpu		b													b						
85	*Gliricidae sepium (jacq) Kunthexwalp*	Leguminoceae	Gliriside				b		b	b														
86	*Heliotropium indicum L.*	Boraginaceae	Tusuk Konde								b						b							
87	*Hibiscus tiliaceus L.*	Malvaceae	Waru			b	b	b	b	d	c			d		b	b	b		d	b		c	
88	*Hyptis suaveolens Poir*	Labiatae	Lampesan			b					d	c							b					
89	*Imosa invisa*	Mimosaceae				c																		
90	*Imperata cylindrica Beauv*	Gramineae	Alang-alang			d					d		d				d		c			d		
91	*Imperata cylindrica L.*	Gramineae	Alang-alang	d	d				d	b		d	d	e	d									
92	*Indigofera sumatrana Gaertn*	Papileonaceae	Daun Tom (Tarum)									a							b			d	b	
93	*Ipomoea aquatica Forssk*	Convolvulaceae	Kangkung				b		c	b	b			c		c		d	c					
94	*Ipomoea aquatica L.*	Convolvulaceae	Kangkung										b		b									
95	*Ipomoea batatas*	Convolvulaceae	Ubi Jalar				b		b															
96	*Ipomoea crassicaulis Rob*	Convolvulaceae	Krangkungan			e	d	c	d	d	d		c	d	d	b		d	b		b	d		
97	*Ipomoea sp.*	Convolvulaceae	Krangkungan			d						c										d		
98	*Jathropa curcas*	Euphorbiaceae	Jarak Pagar			a	b																	

Note :
1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.
a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3f : Plant species identified from several sampling sites of Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
99	*Jathropa Gossypifolia*	Euphorbiaceae	Jarak Merah																					
100	*Jussiena repens L.*	Onagraceae	Krema	c		d			b			b	b	b		d		d	e					
101	*Lantana camara L.*	Verbenaceae	Tembelikan	c	d																			
102	*Laurenta longiflora (L) Peter*	Companulaceae				a																		
103	*Leersia hexandra*	Gramineae	Kolomento										b	b			b	d				b		
104	*Leucaena glauca Bth*	Mimosaceae	Kemlandingan			a	b	b	b			b								b					
105	*Leucaena leucocepala (Lam.) de Wit*		Lamtoro							b	b		b	d	b		b							
106	*Limnocharis flava Buch*	Butomaceae	Genjer																a					
107	*Mangifera indica L.*	Malvaceae	Mangga				b																	
108	*Manihot esculenta (Crantz)*	Euphorbiaceae	Pohong				b		d							b								
109	*Marchantia polymorpha*	Marchantiaceae	Lumut Hati	d	c														d					
110	*Marsilia aquatica*	Marsiliaceae										c												
111	*Marsilia crenata Presl*	Marsileaceae	Semanggi			e																		
112	*Mimosa pudica L.*	Mimosaceae	Putri Malu			c		c		c		c		e										
113	*Morinda citrifolia L.*	Rubiaceae	Pace			a						a						b						
114	*Musa paradisiaca L.*	Musaceae	Pisang			d	b	c		c	d	b		d	c	b	d	d	b	b		c		
115	*Mutingia calabura L.*	Elaecarpaceae	Kersen											c		b	a					a		

Note :

1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.

a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3g : Plant species identified from several sampling sites of Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
116	*Nasturtium monta num Wall*	Brassicaceae	Sawi Tanah		b		b																	
117	*Nephelium lappacum L.*	Sapindaceae	Rambutan							a														
118	*Nephrolepis cordifolia Presl*	Polypodiaceae	Paku Sepat	b	b																			
119	*Nephrolepis sp.*	Polypodiaceae	Paku Sepat				d	d																
120	*Nothopanax quincifolia*	Araliaceae	Ponco Sudo		a																c	c	c	
121	*Nypha fruticans Wurmb*	Palmae	Nipah																					
122	*Orthosiphon stamineus*	Labiatae	Remujung				b																	
123	*Oscinum sanctum L.*	Labiatae	Klampes												a									
124	*Osmunda sp.*	Polypodiaceae		d																				
125	*Oxalis acetofolia*	Oxalidaceae			c																			
126	*Oxalis carniculata L.*	Oxalidaceae	Semanggi Gunung	c																				
127	*Palygonum sp.*	Polygonaceae	Kekawatan										b											
128	*Palystrichum commune*	Palystrychaceae		c	d																			
129	*Panicum repens*	Gramineae	Lempuyang			d	d													b	b	b		
130	*Passiflora faetida L.*	Passifloraceae	Namlang																			b		
131	*Phaseolus vulgaris L.*	Leguminosae	Kacang Tolo														b							
132	*Phyllanthus reticulatus Poir*	Euphorbiaceae	Ketupel Besi																					

Note :
1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.
a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3h : Plant species identified from several sampling sites of Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
133	*Physalis minima L.*	Solanaceae	Ceplukan							b	b													
134	*Pinus merkusii*	Pinaceae	Pinus	b	d															b				
135	*Pithecellobium dulce Bth*	Mimosaceae	Asam londo																					
136	*Pityrogramma calomelanos Link*	Polypodiaceae	Paku Perak			b																		
137	*Plucia indica Less*	Compositae	Beluntas			d														c	d			d
138	*Plumeria acuminata Ait*	Apoccynaceae	Kamboja								b													
139	*Politrias polymorsa*	Gramineae	Kekeratan				e																	
140	*Polystrichum commune*	Polystrichaceae	Lumut Daun	d	d																			
141	*Portulaca oleracea*	Portulacaceae	Krokot							b	d												d	
142	*Portulaca sp.*	Portulacaceae	Krokot															b						
143	*Psidium guajava*	Myrtaceae	Jambu Jawa					b	b							d		b						b
144	*Pterocarpus indicus Willd*	Leguminoceae	Sono						d	b			b										e	a
145	*Rhizophora*	Rhizophoraceae	Jangker																b	b		e	b	
146	*Ricinus communis L.*	Euphorbiaceae	Jarak Jepang									d					b			e	b	e	b	
147	*Saccharum spontaneum L.*	Gramineae	Glagah																d					
148	*Salvinia natans*	Salviniaceae	Patil Lele							b									d					
149	*Salvinia sp.*	Salviniaceae				e			d	c					b									
150	*Selaginella sp.*	Selaginellaceae		e	d																		a	
151	*Sesbania grandiflora Pers*	Leguminoceae	Turi					a	b	b														

Note :

1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.

a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annexe 3i : Plant species identified from several sampling sites of Brantas river.

No	Species Name	Family	Local Name	Sampling Sites																				
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
152	*Sida rhombifolia L.*	Malvaceae	Sedaguri			b		d	d			b			b									
153	*Sida rhomboides*	Malvaceae	Sida										b	b		b								
154	*Solanum licopersicum L.*	Solanaceae	Tomat				b																	
155	*Solanum tarvum Sw*	Solanaceae	Tekokak			b																		
156	*Sonchus arvensis L.*	Compositae				b	b																	
157	*Sonchus arvensis L.*	Aseraceae			b	b																		
158	*Spenoclea zeylanica Gaertz*	Componula-ceae	Gunda (Pacar air)			c			d			b							e				b	
159	*Stachytarpheta jamaicensis Vahl*	Verbenaceae	Pecut Kuda			b	b				c											b		
160	*Swietenia mahagoni*	Meliaceae	Mahoni						b															
161	*Synedrella rodiflora (L) Gaertu*	Asteraceae	Gletangan			b			d															
162	*Tectona grandis L.F*	Verbenaceae	Jati							a													a	
163	*Themeda gigantea*	Gramineae	Rumput Gajah	c	d	b		c	b	e	d													
164	*Thevetia perviana Merr*	Apocyna-ceae	Kenari			b																		
165	*Tithonia difersifolia Rob*	Compositae	Kembang Bulan			c				d														
166	*Tithonia diversifolia Gray*	Compositae	Kembang Bulan			c		c	d															
167	*Tridax procumbens L.*	Compositae	Srunen			d	d			d		d	d	d	d				d	d		d		
168	*Triumfetta bartramia L.*	Tiliaceae	Pulutan			c																		
169	*Typha angustifolia*	Typhaceae	Tipa																	b	d			
170	*Urena lobata*	Malvaceae	Pulutan					c											d			d		
171	*Widelia biflora DC*	Compositae	Langlangkapan			d	b																	
172	*Xylocarpus sp.*	Meliaceae	Jombok																					
173	*Zea mays L.*	Gramineae	Jagung						d															
174	*Zizyphus mauritania Lamk*	Rhomnaceae	Widoro																d	d	b			

1. Sumber Brantas, 2. Junggo, 3. Sengkaling , 4. Malang, 5. Kademangan , 6. Blitar, 7. Ngunut, 8. Papar, 9. Ploso , 10. Padangan, 11. Canggu , 12. Lengkong, 13. Surabaya river, 14. Upper course of Wonokromo river, 15. Gunung sari, 16. Porong river, 17. Wonokromo estuary, 18. Wonokromo Brackish water, 19. Porong estuary, 20. Porong Brackish water, 21. Gisik river estuary.

a. Very rare, b. Rare, c. Moderate, d. Many, e. Abundant

Annex 4a. Size of fish which was caught from the Brantas river. Valus in each collumn are average value (varied between 1-10 individus). Specimens having no size data are fishermen's information from the Brantas river.

No	Latin name	Local name	Weight	Total Length	St. Length	Depth	rs/ds
1	*Achrochordonichthys rugosus*	Jogoripo	-	-	-	-	-
2	*Ambasis nalua*	Pengkih	-	-	-	-	-
3	*Anabas testudinieus*	Betik, betok	43.6	12.5	9.75	3.55	rs
4	*Aplocheilus panchax*	Kepala timah	1.6	4.3	3.2	0.42	rs-ds
5	*Channa striata*	Kutuk	24.18	12.62	10.26	2.02	rs
	(Channa lucius)		66.3	21.1	17.9	3.1	ds
6	*Chanos chanos**	Bandeng	50.5	13.5	10.30	2.7	rs
7	*Clarias batrachus**	Lele lokal	34.1	15	13.1	2.1	ds
			31	15.5	13.48	1.86	rs
8	*Clarias gariepinus*	Lele dumbo	107.6	25.5	23	2.8	ds
9	*Cyclocheilichthys*	Wader,	25.1	12.2	11.6	3.2	ds
	*enoplos**		9.05	9.02	7.2	1.92	rs
10	*Cyprinus carpio*	Tombro	23.7	19.5	16.0	5.5	ds
11	Fam. Cobitidae	Seren	-	-	-	-	-
12	*Glyptothorax platypogon*	Tapel watu	7.3	8.8	7.2	12	ds
13	*Hampala macrolepidota**	Palung	59.56	13.56	8.9	3.36	rs
			70.7	16.9	13.42	3.9	ds
14	*Helostoma temmincki*	Keprek, Tambakan	27.57	11.49	8.98	3.34	rs
15	*Ichthyocampus carce*	Sogoprono	0.75	5.05	3.96	0.7	rs
16	*Labeo chrysophekadion**	Areng-areng	-	-	-	-	-
17	*Labeobarbus siamensis*	Sengkaring	23.9	14.4	12.2	3.3	ds
18	*Macrognathus aculeatus**	Sili	9.1	15	14.1	1.6	ds
			43.2	20.83	19.8	2.23	rs
19	*Macrones gulio**	Baung	169	30	26	4.8	ds
	(Mystus gulio)						
20	*Macrones microcanthus**	Keting	80.5	18.5	14.7	3.3	ds
	(Mystus micracanthus)						
21	*Macrones pogulia*	Berot	-	-	-	-	-
22	*Macrones sp. (M. nemurus*	Lenger.	-	-	-	-	-
	)						
23	*Monopterus albus**	Welud, Welut,	18.2	25.7	25.7	1.0	ds
		Belut	24.9	29.1	29.0	1.0	rs
24	*Mystacoeleucus marginatus*	Bekepek	-	-	-	-	-
25	*Mystus nigriceps**	Bekel	20.2	12.4	10.1	1.9	rs
26	*Nemachilus fasciatus**	Uceng	0.9	6.1	5.0	0.6	rs
27	*Ophiocephalus gachua* HB.	Kotes, Gabus	30.5	14	11.3	2.4	rs
	Channa gachua						

* : indigenous fish
ds: dry season
rs: rainy season

Annex 4b. continued

28	*Ophiocephalus melanopterus* *(Channa melanopterus)*	Bekes	61.27	17.02	14.15	2.37	rs
29	*Osphpronemus goramy*	Gurame	19.8	10.1	8.7	3.4	ds
30	*Osteochilus haseltii**	Milem, Nilem, Bader muntu, mangut	16.62	10.12	8.17	2.4	rs
31	*Osteochilus spilurus*		8.27	8.17	6.27	1.67	rs
32	*Pangasius djambal*	Jambal	1.0	3.9	3	0.3	ds
33	*Pangasius micronemus**	Jendil/Wakal	95.7	22.1	19.1	3.9	ds
			37.85	16.05	13.4	3.25	rs
34	*Pangasius nasutus*	Mengkreng	-	-	-	-	-
35	*Poecilia reticulata*	Ikan seribu	1.5	4.1	3.0	0.4	ds
			1.3	3.9	2.8	0.3	rs
36	*Puntius binotatus**	Cakul, Gathul	1.5	4.2	3.2	0.68	ds
			1.85	4.79	3.62	0.8	rs
37	*Puntius bromoides** *(Barbodes balleroides)*	Bader bang	83.9	15.7	12.3	4.7	ds
			63.01	15.16	12.24	4.26	rs
38	*Puntius javanicus (Blkr)** *(Barbodes gonionatus)*	Tawes, Putian	46.7	14.7	11.2	4.0	ds
39	*Puntius lawak** *(Kalimantania lawak)*	Lawak	-	-	-	-	-
40	*Rasbora argyrotaenia* *	Wader pari	6.7	8.0	20.4	1.65	ds
			6.8	8.8	7.0	1.7	rs
41	*Sukhermouth catfishes*	Suckermud, Cakarmut	37.2	21.5	15.1	3.4	ds
			71.33	18.1	12.9	2.3	rs
42	*Tilapia mossambica* *(Oreochomis mossambicus)*	Mujair	43.4	13.5	10.5	4.3	ds
			38.55	12.9	10.15	3.65	rs
43	*Tilapia nilotica* *(Oreochomis niloticus)*	Nila	67.5	13.3	11	4.7	ds
			79.12	14.15	11.35	4.9	rs
44	*Trichogaster trichopterus*	Sepat	12.2	8.6	7.0	3.0	ds
			13.8	8.5	6.4	3.0	rs
45	nd	Blancer	-	-	-	-	-
46	nd	Garingan	15.45	11.45	9.3	1.65	rs
47	nd	Benculing	50.1	14.0	12	2.7	ds
48	nd	Kebogerang	-	-	-	-	-
49	nd species1	nd	0.9	3.0	2.4	0.9	rs
50	nd species2	nd	60	15.2	13.4	4.0	ds
51	nd species3	nd	10.5	6.5	5.2	2.1	rs

* : indigenous fish
ds: dry season
rs: rainy season