METHODOLOGY

Sampling methods

F i s h e s

Fishes were caught directly and indirectly by fishermen or local people by using a net and other tools such as traditional equipment and hucks at the running water area and the man-made lakes (reservoirs) area, as listed on the Table 1. The fishes were caught both at night and daytime to obtain their composition. In some cases, fishes data which were not be collected because of hard to find were also taken into account by interviewing some fishermen of the Brantas river.

Table 1 : Sampling location and equipments used to catch fishes.

No	Sampling Site	Area of river	Equipment
1	Sengkaling	upper	Huck, Net
2	Malang	upper	Huck, Seser
3	Sengguruh	upper	Huck, Net
4	Ngembul	middle	Huck, Net, Sawer
5	Kademangan	middle	Huck, Net, Sawer
6	Ngunut	middle	Huck, Net
7	Papar	middle	Huck, Net
8	Padangan	lower	Net
9	Porong river	lower	Huck, Net
10	Canggu	lower	seser
11	Gunung sari	lower	Huck
12	Wonokromo river	lower	Huck, Net
13	Wonokromo Estuary	lower	Huck, Net
14	Gisik river	lower	Huck, Net

The fishes of the Brantas river are identified after Saanin (1968) and Kottelat, *et al.*(1993). The weight and length of fishes were also be measured. Each type of caught fishes was preserved with alcohol 70 % or formalin 4 %.

Macroinvertebrates

Macroinvertebrates were sampled by a handnet (20x30 cm, mesh size 0.5 mm) with the "kicking" method for hard substratum, and by using Ekman Grab (size 15 x 15 cm) for soft substratum. Each sample was taken from an area with length of 5 m for the stony substratum. Each sampling site is considered based on different substratum and its condition.

Standard procedures follow with respect to the preservation, sorting and storage of field samples as mentioned in Crombaghs and Hermans (1991). Macroinvertebrates are identified based on Chu (1949), Quigley (1977), Macan (1979), Edington and Hildrew (1981) and Gardeniers (1988).

Plankton and periphyton

Plankton are collected by a plankton net. Sixty liters of water were taken from each area. Periphyton were sampled from the stones and gravel for each site. Several sites of plankton and periphyton are different because of their different habitat. Periphyton in the stones were taken with using brush or rubber from an area of 10 cm2 (in 5 m2 area of river) and preserved with Lugol's. The Data were analysed based on its abundance per unit of volume. Periphyton were identified based on Needham and Needham (1969), Davis (1955), Edmonson (1959) and Sachlan (1970).

Terrestrial and Aquatic Plant

Plant terrestrial was studied in the upper, middle and lower basin of the Brantas river. Transect of trees were assessed in 10 x 10 m plots, and other flora were taken from 5 x 5 m and 1 m x 1 m subplots depend on the tail and type of flora.

Aquatic plants were also counted directly based on their relative abundance on each site, especially at the surface of water stream.

Note for wet season survey

Terrestrial vegetation in wet season is not changed compared to earlier observation. Thus, in offering data of terrestrial vegetation, the observation was taken only for some "new" specimen which are not listed on the earlier report (Risjani, *et al.*, 1997). The quantity of plant was noted based on their occurrence percentage.

Mangrove Forest

The study area covers a lower part of the Brantas river basin. By using transect lines, an ecological study of mangrove forest was carried out in the delta system. Trees (diameter at breast height more than 10 cm), saplings (trees with diameter 2-9.90 cm) and seedlings present were assessed in 10 m x 10 m plots for trees, 5 m x 5 m and 1 m x 1 m subplots at certain intervals for saplings and seedling respectively. Some characteristics of mangrove forest in East of Surabaya such as: their type and their percentage quantity were noted. The specimen were identified according to Backer and van den Brink (1968).

Other Fauna

Other fauna which are found along the Brantas River were taken into account. These fauna include aquatic and terrestrial fauna at each sampling site.

Ecological Characteristics

The special characteristics of different types of land use in each sampling location were noted. Physical and chemical factor of water and soil in the river such as type of substratum, water current, depth, temperature, and dissolved oxygen of the water were measured. Salinity was determined in the lower area of the river

only. Concentration of nitrate and phosphate were determined only on the sites of plankton and periphyton to analyse the presence of their nutrient in the environment. Ecological factors which have been determined with their method of measurement are listed on the Table 2.

Table 2. Ecological factors

Parameter	Unit	Method/Equipment
Current Velocity	cm/sec	Currentmeter
Type of substratum	%	Sampling Core
Depth of water	cm	Metric
Temperature	°C	Thermometer
Dissolved oxygen	mg/l	Titrimetric
BOD_5		Titrimetric
Salinity	promil	Refractometer
NO_3^-	mg/l	spectrophotometer/Kit
PO_4^-	mg/l	spectrophotometer/Kit

Time of Schedule

The Biodiversity survey is devided into Phase 1 and 2 each for dry and rainy season. The time schedule for dry season survey (Phase 1) is taken on July to August and for rainy season survey (Phase 2) is done on November and December. Each activity and its schedule is shown on the Table 3.

Table 3 : Time of schedule for each activity.

Activities	Month				
	August 1 2 3 4	September 1 2 3 4	October 1 2 3 4	November 1 2 3 4	December 1 2 3 4
Coordination and preparation	x				
Field orientation	x				
Dry season survey: - Upper region - Middle region - Lower region	 xx xx xx				
Identification in the laboratory	xxxxxxx				
Chemical analyses	xxxxxxx				
Data analyses, draft & report preparation (dry season)	xx	xxx			
Rainy season survey: - Upper region - Middle region - Lower region				 xxx xxx xx	 xx
Identification in the laboratory				xxxxxxxxx	xxxx
Chemical analyses				xxxxxxxxx	xxxx
Draft final report preparation					xxxxx
Final report					xxxxxxx

SITE DESCRIPTION

The Brantas river occupies approximately 320 km from it source at Arjuno Mount to the river mouths in the deltaic system and in Surabaya Estuary. The present study which carried out in the Brantas river covers upperstream part at Brantas source to Lower Basin, it includes the main river and its tributaries such as Wonokromo river and Rorong river. Each sampling site is considered based on the different habitat of living communities (Fig. 1). Table 4. shows description and physical condition of each site.

Physical characteristic

Sumber Brantas

The site (Fig. 2) is located at Sumber Brantas, Tulungrejo village, Kecamatan Bumiaji. The main land use in this site is a semi natural forest.This place is a water source where from this site springs the water of the Brantas River, and it is a part of Arboretrum project of Perum Jasa Tirta. From its source, the water flows to the South by passing river stream of 40 - 120 cm wide and of 1-20 cm depth. The substratum is dominated by gravel and stone. The stream has a current velocity of 0.341 m/sec. temperature of 16°C

Junggo

This place (Fig. 3) is a semi natural forest, located in Coban Talun Area at Junggo, Tulungrejo village, Kecamatan Bumiaji. The river has a wide of 2-5 m, a depth of 15-40 cm and a current flow of 0.28 m/sec in dry season and 0.863 m/sec in wet season. The water is still clean and the substratum is generaly consist of cobble, gravel, stone and sand. In this site, the water temperature has arised to 22°C.

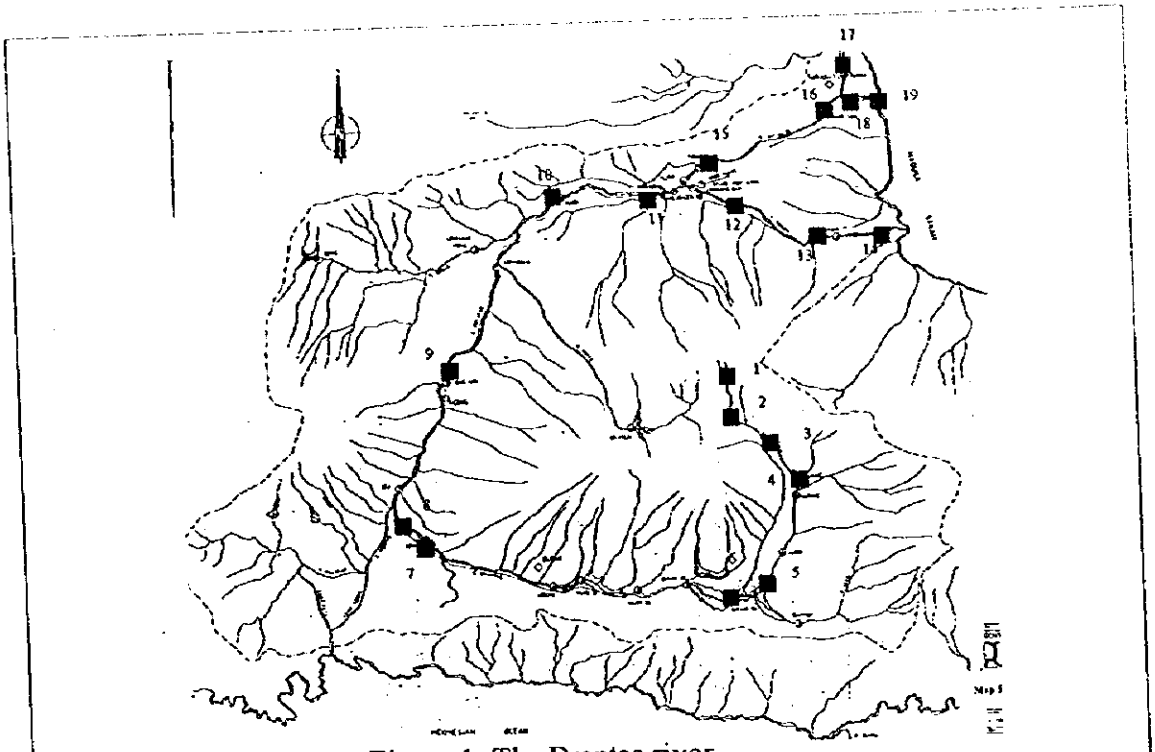


Figure 1. The Brantas river

Legend :

1. Sumber Brantas
2. Junggo
3. Sengkaling
4. Malang
5. Sengguruh (resevoirs)
6. Karangkates (resevoirs)
7. Kademangan
8. Ngunut
9. Papar
10. Ploso
11. Padangan
12. Porong upstream
13. Porong middle
14. Porong estuary
15. Canggu (the upstream of Surabaya river)
16. Gunungsari (the downstream of Surabaya river)
17. Petekan (estuary of Mas river)
18. The upstream of Wonokromo river
19. The downstream of Wonokromo river

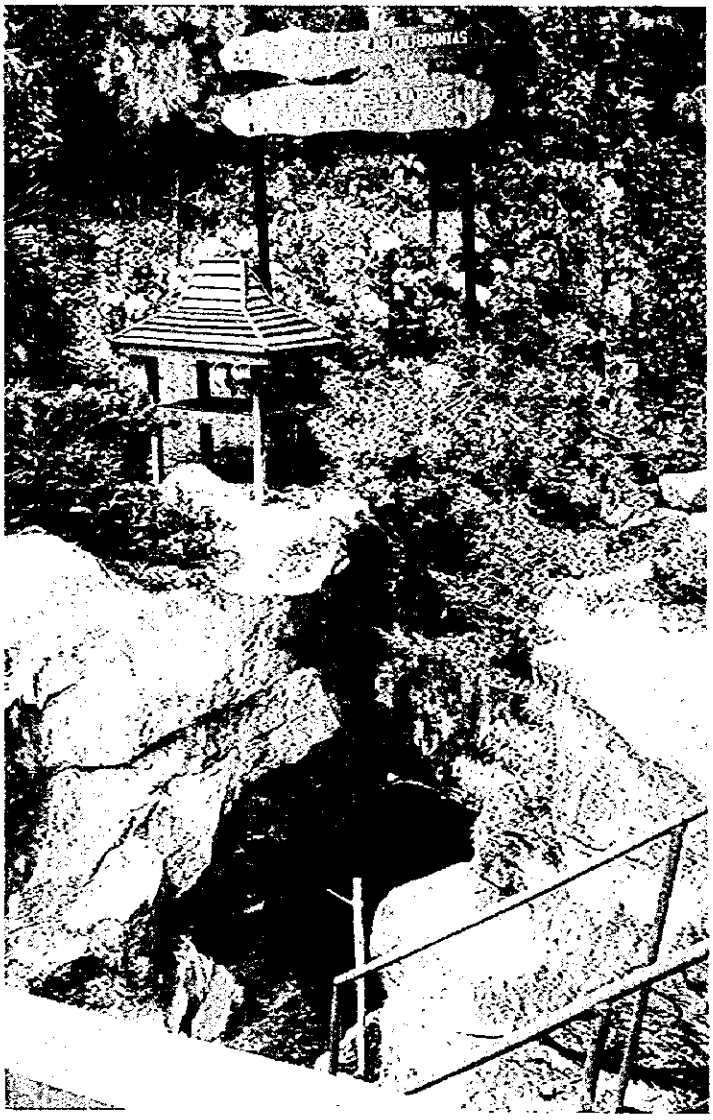


Figure 2. Water source in Sumber Brantas at Arjuno Mount. From this site springs the water of the Brantas River. (Photo: YR)

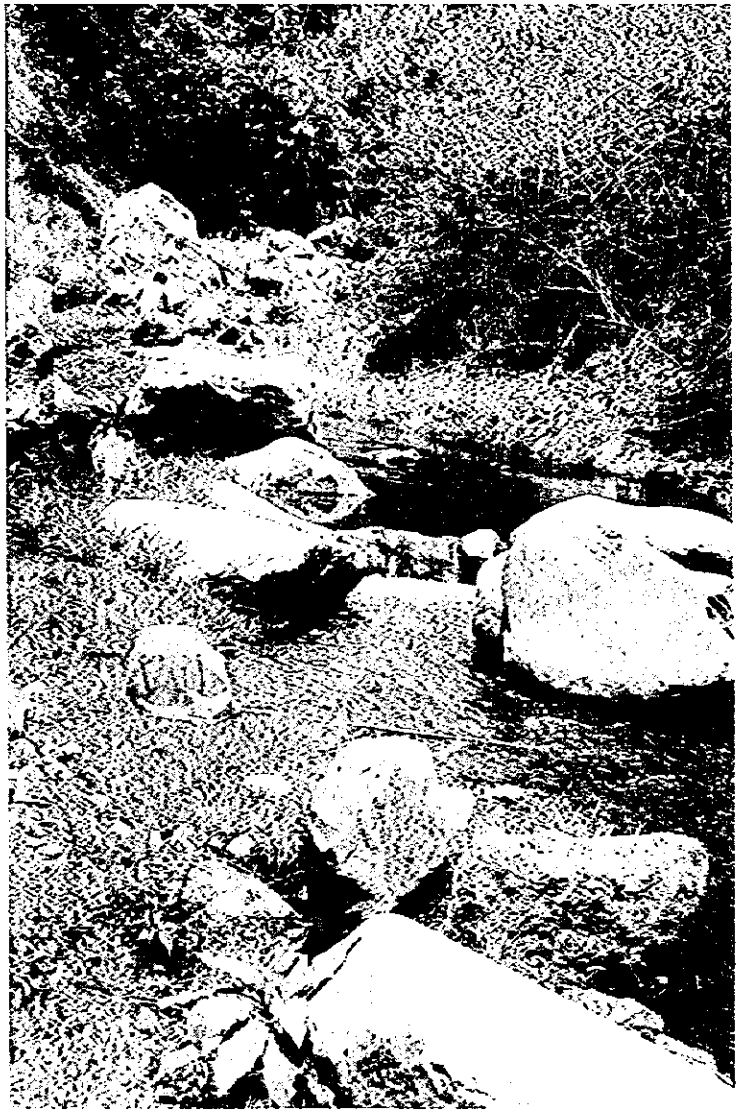
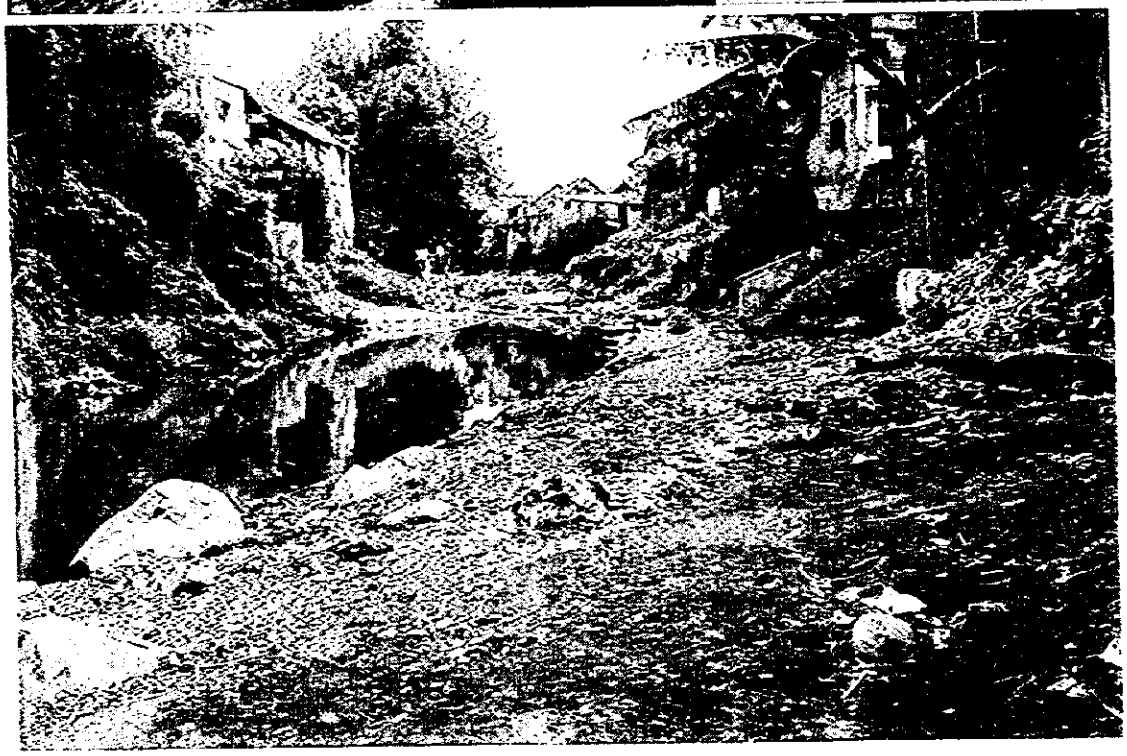


Figure 3. Sampling site at the upper stream of the Brantas River in Junggo. (Photo YR)

A



B

Figure 4. Sampling locations at Malang Regency: A. Sengkaling B. Malang.(Photo: YR)

A

B

Figure 5. Study area at Sengguruh (A) and Karangkates Reservoir (B). (Photos: EYH).

Sengkaling

This rice field area is situated near settlement complex at Sengkaling, Kecamatan Dau, Kabupaten Malang. The water is not very clear with a brownish color which indicate a high turbidity. The water current is about 0.23 - 0.465 m/sec with the temperature of 24-26°C. The substratum is dominated by gravel and stone. Figure 4 shows the description of sampling site at Sengkaling.

Malang

This is a settlement area located in Jl. Juanda, Kelurahan Jodipan, Malang (Figure 4). The river has a wide of about 4 meters, a depth of 20-40 cm and a current velocity of 0.3 m/sec in dry season, 0.5 m/sec in wet season. River bottom is dominated by gravel and mud. The water is not clear with many organic sewage in some part of river area. The water is used for many purpose by the local people, i.e. defecation, bathing, washing by using soap and detergent, also throwing waste disposal like plastics, garbage disposal, etc. The water temperature is about 23-29°C at noon.

Sengguruh

This sampling site is located in the village of Sengguruh, Kepanjen, in the south of Malang Regency. The width of river is about 100 meters, the depth of 1.3-3 m and with stagnant condition. Visually as can be seen on the area, the water has a greenish colour with muddy substratum at the bottom of river. The water temperature is about 26-32.5°C.

Karangkates Reservoir

Waduk Karang Kates is the biggest reservoir which has been constructed by Brantas Project Authority in 1970 for many objectives: irrigation, electricity, flood control and water supply. The place is situated in Sumberpucung Subregency in Malang

(Figure 5). The substratum is commonly of mud. This reservoir with stagnant water has a temperature of 29-33.5°C.

Kademangan

Kademangan is situated in the middle part of the Brantas river with the main land use is a combination of dry land cultivation and settlement area (Fig. 6). The river has a width of up to 150 m and a depth of 50 cm during dry season and up to 200 cm during rainy season. The type of substratum is a combination of gravel, stone and sandy. Current velocity varies from 0.34 to 1.05 m/sec with a temperature of 28°C.

Ngunut

Ngunut is situated approximately 7 Km from Kademangan. Near this sampling site there is a village. The people of this village use the river for fishing. The river has a width of 75 cm with a depth of varies from 20 to 50 cm. In this place the current velocity is slower than in Kademangan with type of substratum commonly gravel. Benthos algae can grow at the surface of the stone. During the dry season, the temperature of the river is 30° C.

Papar

Papar is situated in the village at the regency of Kediri. The course of the river flows to the North, and has a width of 75 m; a depth varies from 20 cm to 2 m, current velocity of 2.25 m/sec. in the dry season. Benthic algae can grow at the surface of the stone in the bottom area.

Ploso

Ploso is situated near Papar. The main land use, between Ploso and Papar, are for agricultural and village activities. The river bank is dominated by shrubs. The river's width is 100 m, with a depth varies 20 - 30 cm, a current velocity of 0.4-.0.6 m/sec and water temperature of 30-31°C.

Padangan

Padangan is located at Mojokerto city where the Brantas river splits into two parts namely the Surabaya river and the Porong river. The main land use of the river is for the dry land cultivation. The width of the river is 150 cm and its depth varies from 1 to 2 m, with has a slow current velocity. The type of substratum is commonly muddy. The higher plants, for instance, *Eichhornia sp* and *Ipomoea sp* grow along the banks. The water temperature of the river is 28-32° C.

Porong river

This sampling place is located in a settlement area proache to road and a bridge at Kabupaten Sidoarjo. The river with a stagnant water is covered by aquatic plant, *Eichhornia crassipes* (Eceng Gondok), which occupy about 30 % of the total area in dry season. These plants have covered all part of river (nearly 100%) in wet season. The river has a 50-60 m of wide, about 1.5 m depth and around 31°C of water temperature. The substratum is consist of fine sand and mud.

Porong Estuary

The Porong estuary is situated at Sidoarjo regency, with a width of about 50 m and a depth of 5 m, the colour of the water is greenish. The river's bank are planted by vegetable agriculturals. The current velocity is slow, with the black muddy substratum. The temperature of estuary taken from the sampling site is 30°C.

Canggu

Canggu is situated in the Surabaya river. The river has a width of 15_m and a depth of 1 - 5 m with fast current velocity of 1.50 to 2 m/sec. The type of stratum are full with muddy. The colour of the water is greenish. The river banks are planted by vegetables during the rainy season. The temperature is of 29-31°C (Fig. 6).

Table 4. Site Description and Physical condition

Site	Land use	Type of sub-stratum	Width cm	Depth m		Current velocity m/sec		Temperature (°C)	
				DS	WS	DS	WS	DS	WS
Sumber Brantas	semi natural forest	gravel, sandy	0.40-1.20	0.1	0.15	0.341	0.341	16	16
Junggo	semi natural forest	stone, gravel, cobble	2	0.15	0.30	0.20	0.863	22	22
Sengkaling	rice field	stone, gravel	2	0.1	0.50	0.23	0.465	24	26.5
Malang	settlement	gravel	4	0.2	0.40	0.30	0.529	23	29.0
Sengguruh	village	muddy	100	1.5	3	stagnant	stagnant	26	32.5
Karangkates reservoir	village	mud	lake	6	7	stagnant	stagnant	29	33.5
Kademangan	settlement, unirrigated agricultural field	stone, gravel, sandy	150-200	0.5	2	0.34	1.05	28	30
Ngunut	village	gravel	75	0.2	0.5	0.30	0.52	30	31.5
Papar	village	gravel	75	0.2	0.2-2		0.667	30	31
Ploso	village	muddy, gravel	100	0.2	0.3	0.40	0.65	30	31
Padangan	road, pond	sandy, muddy	150	1.0		stagnant	stagnant	29	32
Porong river	road	fine sandy, muddy	50	0.5	covered	stagnant	stagnant	31	nd
Porong estuary	mangrove	muddy	50	5	5.5	stagnant	stagnant	30	30
Canggu	road	black muddy	15-25	1.0	1.5	1.50	2.3	29	31
Gunung sari	city	black muddy	100	4.5	5	0.11	0.3	29.5	32
Petekan	city	coarse, sandy, muddy	50	1.5	2	1.33	1.5	29	32
Wonokromo river	city	black muddy	60	5	5	stagnant	0.1	29	33
Wonokromo estuary	mangrove	black muddy	60	10	10	stagnant	0.1	29	33

DS: Dry season
WS: Wet season

Gunung Sari

This sampling place is located in a city (Surabaya) with dense population around the river of about 100 wide. The river is used for disposal many domestic waste by local people. The water is very polluted, with dark color and having litle current (0.11-0.3 m/sec). The bottom of river is dominated by black mud and the water temperature is 29-30°C.

Petekan

Petekan is situated in the mouth of the Kali Mas river (Fig. 7). The river has a width of 50 m, a depth of 1.50 to 2 m, with slow current velocity and with the black muddy substratum. Its temperature is 29°C. Macrophyte grow along the river's banks.

Wonokromo river

Wonokromo river is situated at a center of city (Surabaya). This wide river (around 60 m of wide and 5 m of depth) has a very little current and dominated by black mud at the bottom. The water is very polluted with dark color. Some part of river are grown by eceng gondok which floating (25% of the area) on the surface water. The water temperatur is 29°C on the afternoon.

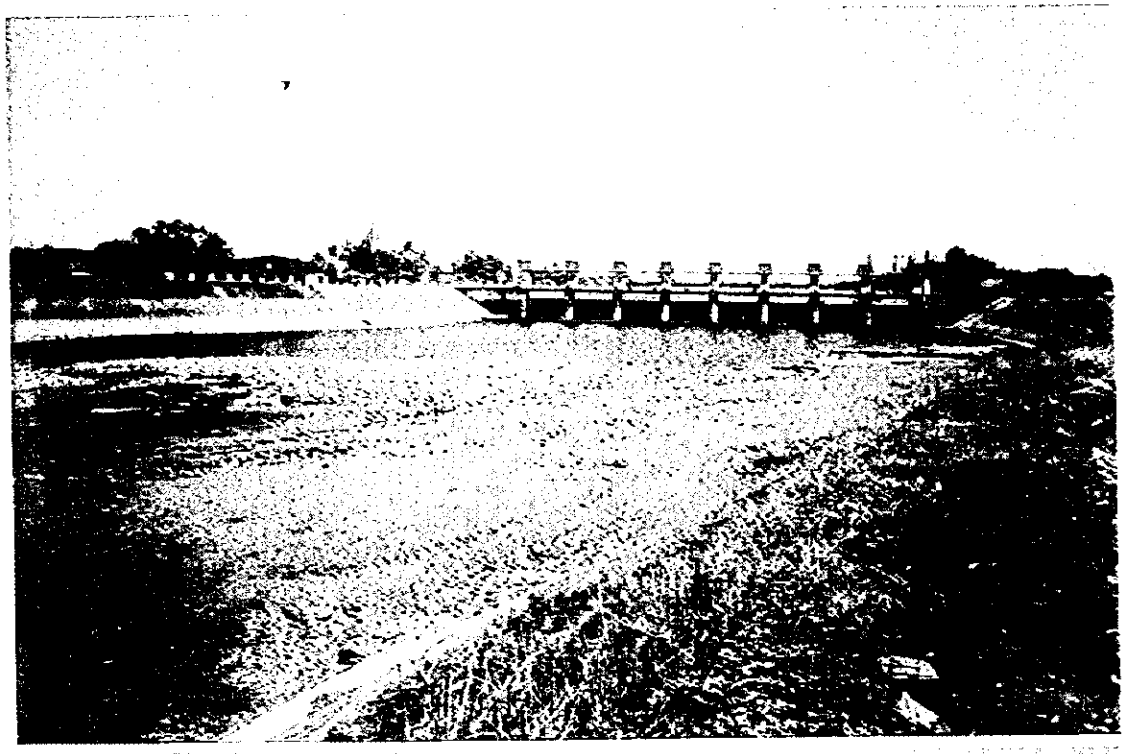
Wonokromo Estuary

Located at East of city (Surabaya), this big river (60-75 wide, 6-10 m depth) is arounded by terrestrial plants. The plants which is dominant are waru, mangrove, petai and alang-alang, while at the western part many banana trees (*M. paradisiaca*) are planted along the river area. The water temperatur is 33°C on the afternoon, with little current velocity and a brackish sense (salinity: 3 promil). The mangrove structure is taken place in the brackishwater ponds area located between the estuary and the coastal area at the delta system (Figure 8).

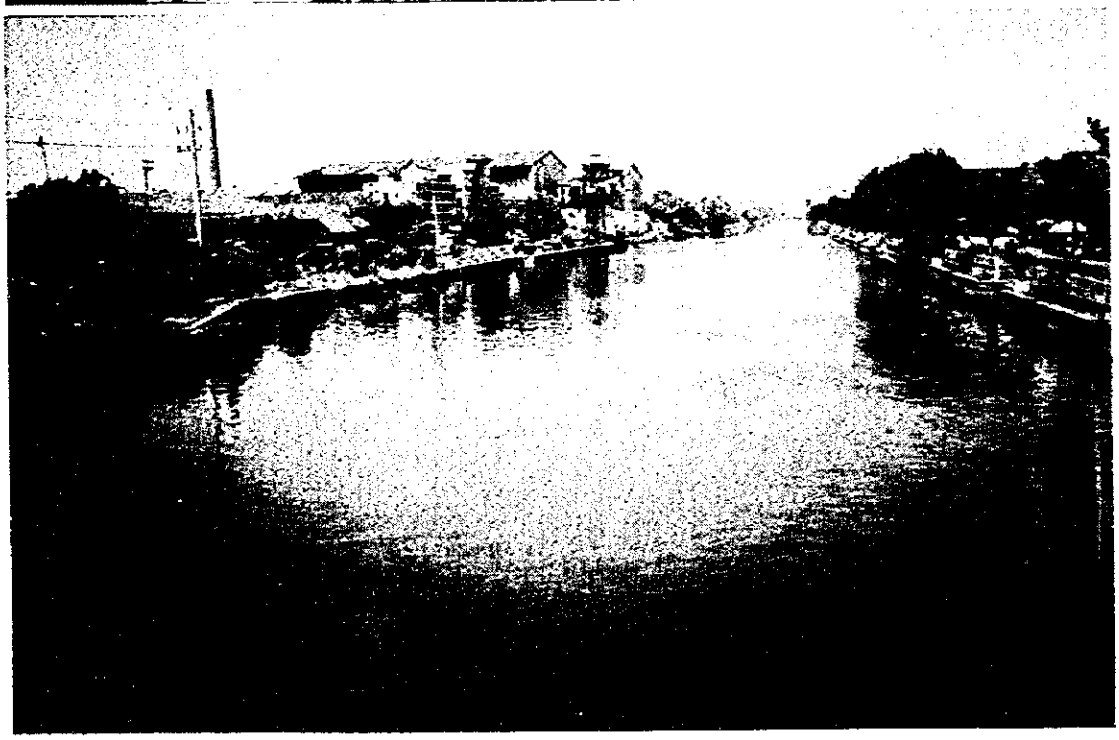
A

B

Figure 6. Sampling sites in Kademangan (A) and Canggu (B).
Photos: EYH & SS



A



B

Figure 7. Sampling sites in Lengkong (A) and Petekan, Surabaya estuary (B). (Photos: SS)

A

B

Figure 8. Sampling sites in Wonokromo estuary (A) and in the Brackishwater ponds in Wonokromo estuary (B).(Photos: SS & YR)

Chemical Characteristics

Dissolved oxygen

During the dry season dissolved oxygen content are high, between 6.76 and 8.4 mg/l in all upperstream stations (from Brantas source to Sengguruh Reservoir) even when some pollution comes in as in Malang. The value is still high in the middle stations (between 4.28 to 9.12 mg/l at Kademangan, Padangan, Papar, Ploso and Canggu). In the lowerstream part of the Brantas River dissolved oxygen drops sharply to about half of the original value, except at Canggu (6.08 mg/l) and Wonokromo estuary (6.89) due to reaeration from water turbulence at Canggu and wave action in the estuary.

During the rainy season the DO value is high in the upperstream part between 5.37 to 10.59 mg/l. In the middle part of the Brantas River the value maintained on the range from 6.3 to 8.14 mg/l, excluded at Karangkates reservoir, the value decreased to 2.9 mg/l. The variation of dissolved oxygen is shown on the Figure 9.

As mentioned above that in the upperstream of the Brantas river the DO value is high either in the dry or in the rainy season. This value tend to decrease in the lower part. This pattern can be explained as can be summerized here.

1. The river substratum of the upperstream part is dominated by gravels, cobbles and stones.
2. The current velocity is higher in the upperstream than in the lowerstream.
3. The difference of altitude between sampling sites in the upperstream and in the lowerstream of the river.

These three reasons makes a higher turbulence of water in the upperstream part than in the lower part of the Brantas river.

Biological Oxygen Demand

Biological oxygen Demand (BOD_5) gives a low value (below 3 mg/l) in the stations of upperstream part at Sumber Brantas and Junggo. BOD value is initiated to increase at Sengkaling (3.55 mg/l in the dry season and 5.24 mg/l in the rainy season) and in Malang (3.20 mg/l in the dry season and 4.22 in the rainy season). In Kademangan, Ngunut and Papar, the BOD is higher in the rainy season (between 4.6 to 5.99 mg/l) than in the dry season (below 3 mg/l). From Padangan (Kediri) to the river mouth, the BOD value rise to more than 6 mg/l, especially in the rainy season. The BOD fluctuation is shown on the Figure 9.

Upperstream part of the river has been polluted which is shown by the higher value of BOD in Sengkaling and Malang. The BOD value during dry and rainy season, from the upperstream part to the mouth, has the same pattern: lower in the upperstream and tend to rise in the lower part of the Brantas River. This is due to organic pollution which is higher in the lower part of the Brantas River.

Nitrate and Phosphate

Nitrate shows vary between stations from less than 1 mg/l to 12 mg/l during the dry season and from 1 to 7 mg/l during the rainy season. The higher value (7 mg/l and more) is shown at Sengkaling and Malang (Figure 10).

Figure 10 shows that during the dry season, phosphate is below of 1 mg/l in all stations, only in Sengkaling, Malang and Papar which present above that value. Higher concentration of phosphate (approximately 1 mg/l) during rainy season can be seen in Malang, Petekan and Wonokromo river.

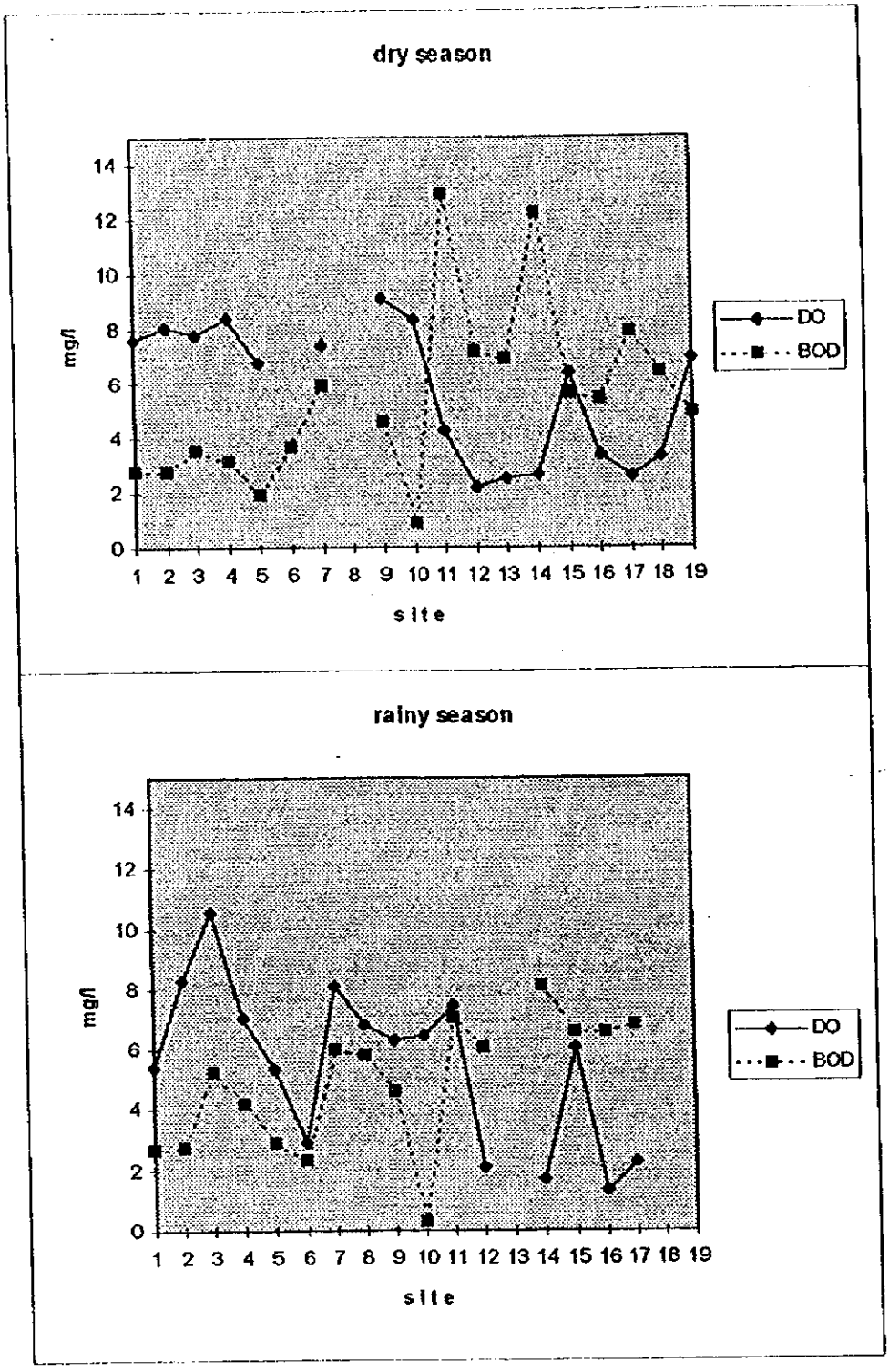


Figure 9: Dissolved oxygen and Biological Oxygen Demand (BOD) along the Brantas river in the dry and rainy season 1997.

Site: 1. Sb Brantas; 2. Junggo; 3. Sengkaling; 4. Malang; 5. Sengguruh; 6. Karangkates reservoir; 7. Kademangan; 8. Ngunut; 9. Papar; 10. Ploso; 11. Padangan; 12. Lengkong; 13. Porong; 14. Porong estuary; 15. Canggu; 16. Gunung sari (Surabaya river); 17. Petekan (Surabaya estuary); 18. Wonokromo; 19. Wonokromo estuary.

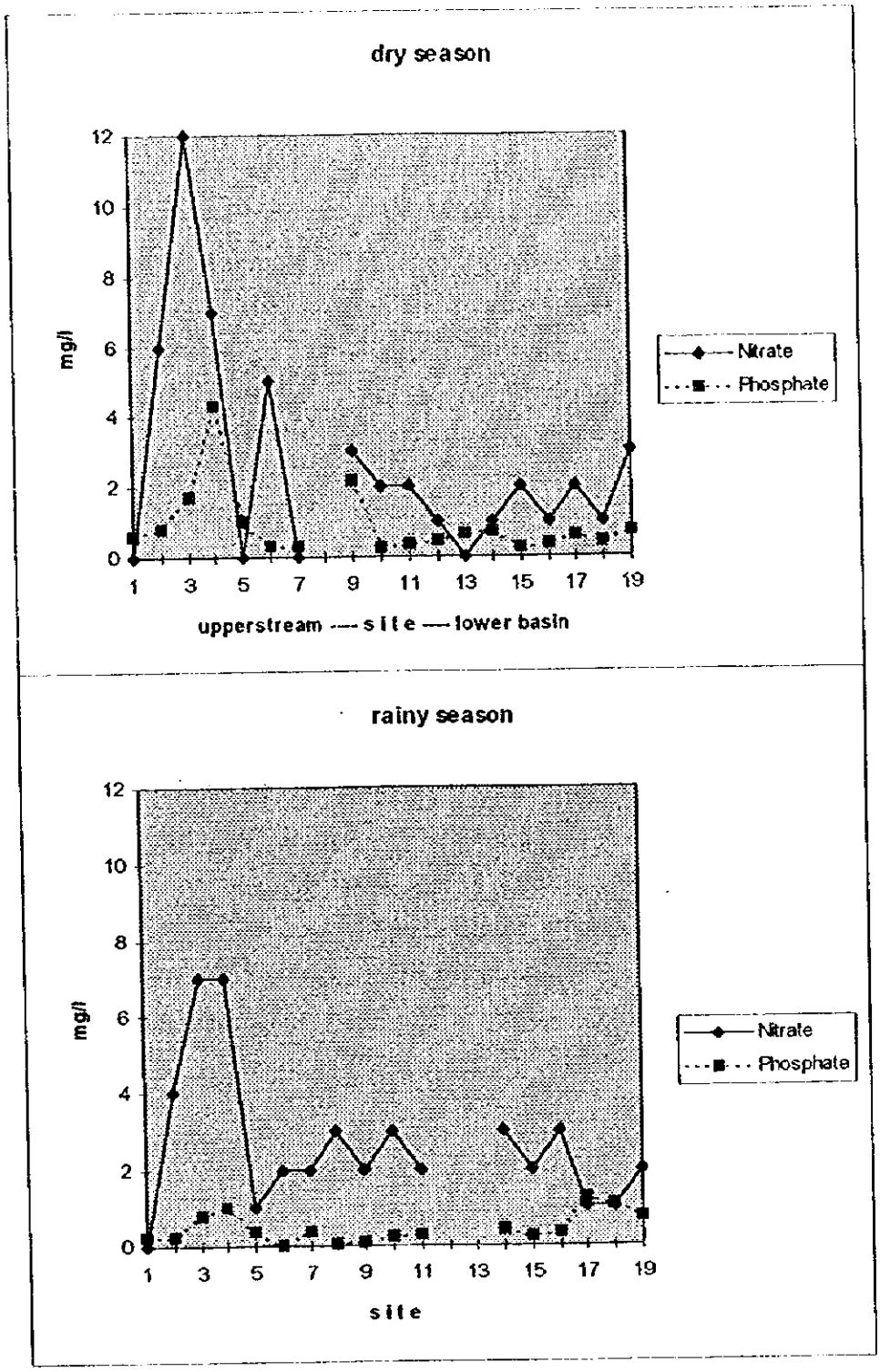


Figure 10. The concentration of Nitrate and phosphate of each site in the dry and rainy season 1997.

Site: 1. Sb Brantas; 2. Junggo; 3. Sengkaling; 4. Malang; 5. Sengguruh; 6. Karangkates reservoir; 7. Kademangan; 8. Ngunut; 9. Papar; 10. Ploso; 11. Padangan; 12. Lengkong; 13. Porong; 14. Porong estuary; 15. Canggu; 16. Gunung sari (Surabaya river); 17. Petekan (Surabaya estuary); 18. Wonokromo; 19. Wonokromo estuary.

It is known that drainage from agricultural land produces large amounts of nitrate and phosphate. The concentration of nitrate and phoshate which reach the highest value in Sengkaling may be caused by farming and rice field activities, such as fertilization which flown into the river. While in Malang, it can be influenced by detergent from washing activities and domestic waste. The value of nitrate and phosphate can also be influenced by these concentrations in the substratums.

pH

The pH value is different between the dry and rainy season. As can be seen on the Fig. 11, the higher value (pH 9) is shown during dry season especially in the upperstream part at Sumber Brantas and Junggo. Higher pH values are associated with calcareous soil which is higher in the upperstream part at Arjuno Mount. While in the rainy season, pH decrease to about 5 in these sites because of acid rainfall. Normaly rain has a fairly low pH because of its high content of carbon dioxide and because sulphate is often present as free acid. Humic acids which are washed out by rainfall may also influence the decrease of pH value.

This figure shows that the variation of pH from the spring water to the mouth is not high (varie between 5 to 7) during the rainy season.

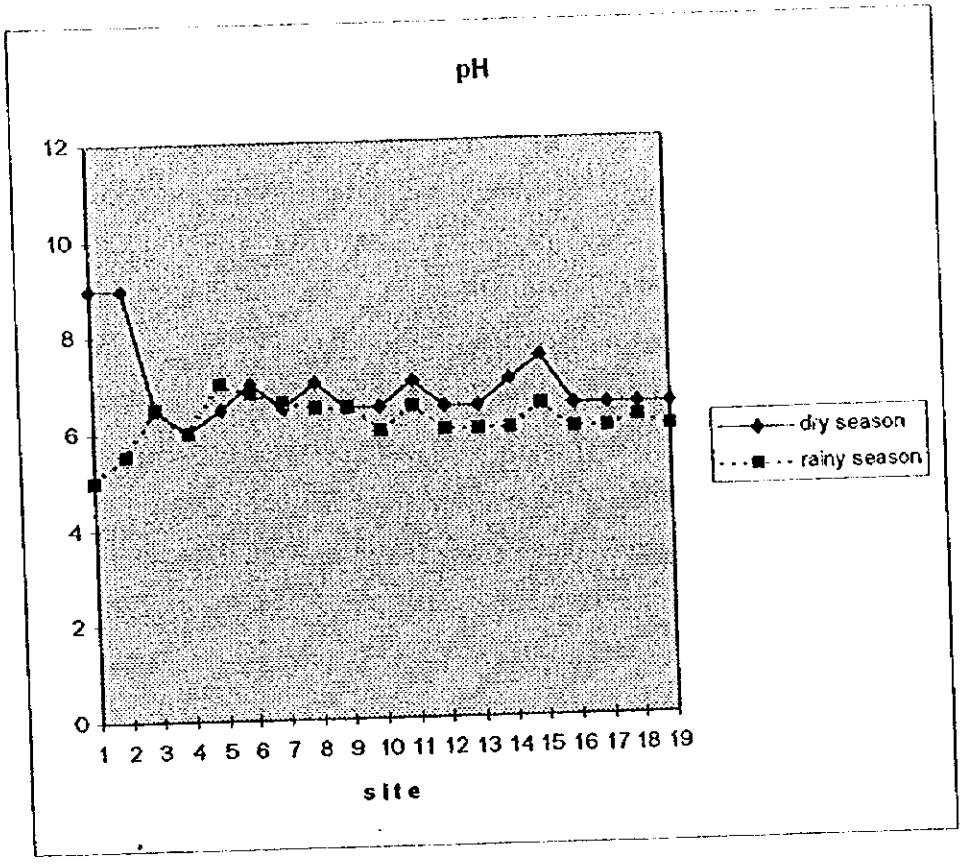


Figure 11. The value of pH of each site in the Brantas river during the dry and rainy season 1997. Site: 1. Sb Brantas; 2. Junggo; 3. Sengkaling; 4. Malang; 5. Sengguruh; 6. Karangkates reservoir; 7. Kademangan; 8. Ngunut; 9. Papar; 10. Ploso; 11. Padangan; 12. Lengkong; 13. Porong; 14. Porong estuary; 15. Canggu; 16. Gunung sari (Surabaya river); 17. Petekan (Surabaya estuary); 18. Wonokromo; 19. Wonokromo estuary.

FISHES COMMUNITIES

Historical data of fishes caught in the Brantas River

The past fishes data of the Brantas river were written by Weber and de Beaufort from 1916 to 1962. According to the data, there were 87 species which are listed on the Table 5. Most of these species were family derived of Cyprinidae, followed by Gobiidae and Clupeidae. Eight years later Wardoyo and Sukimin collected fishes data which be obtained from their observations and interviews. The number of species is not high, as can be seen on the Table 6, there are only 18 species (18 fish types and 2 macroinvertebrates) in 1970.

Table 5. Indigenous Fishes of the Brantas River (Source: Weber and De Beaufort, 1962 *in* Susilo *et al*, 1993 and Kottelat, 1993)

No	Old name after Weber & de Beaufort (1962) and Saanin (1968)	New name after Kottelat (1993)	Family
1.	Acanthopsis choirorhynchus	Acantopsis dialuzona	Cobitidae
2.	Acentrogobius chlorostigmatoides	Aulopareia unicolor	Gobiidae
3.	Acentrogobius caninus	Acentrogobius caninus	Gobiidae
4.	Acentrogobius cyanomos	Acentrogobius cyanomos	Gobiidae
5.	Albula vulpes	Albula glossodonta	Albulidae
6.	Anguilla elphinstonei	Anguilla nebulosa	Anguillidae
7.	Apocryptodon madurensis		Gobiidae
8.	Arius coelatus	Arius caelatus	Ariidae
9.	Tachysurus maculatus	Arius maculatus	Bagaridae
10.	Barbichthys laevis	Barbichthys laevis	Cyprinidae
11.	Batrachocephalus mino		Bagridae
12.	Boleophthalmus boddarti	Boleophthalmus boddarti	Gobiidae
13.	Bostrichthys sinensis	Bostrychus sinensis	Eleotrididae
14.	Botia grey		Combitidae
15.	Branchygobius nunus	Brachygobius doriae	Gobiidae

16.	Branchygobius xanthozona	Hypogymnogobius xanthozona	Gobiidae
17.	Butis melanostigma	Butis humeralis	Eleotrididae
18.	Chanos chanos	Chanos chanos	Chanidae
19.	Chela oxygaster	Oxygaster anomalura	Cyprinidae
20.	Chela oxygastroides	Parachela orygastroides	Cyprinidae
21.	Clarias batrachus	Clarias batrachus	Clariidae
22.	Clarias melanoderma (Blkr)	Clarias meladerma	Clariidae
23.	Coilia dussumieri	Coilia dussumieri	Engraulididae
24.	Crossocheilus cobitis	Crossocheilus cobitis	Cyprinidae
25.	Crossocheilus oblongus	Crossocheilus oblongus	Cyprinidae
26.	Cryptopterus bicirrhis	Kryptopterus bicirrhis	Siluridae
27.	Cyclocheilichthys armatus	Cyclocheilichthys armatus	Cyprinidae
28.	Cyclocheilichthys enoplos	Cyclocheilichthys enoplos	Cyprinidae
29.	Dangila cuvieri (CV)	Labiobarbus leptocheilus	Cyprinidae
30.	Engraulis kammalensis (Blkr)		Engraulididae
31.	Engraulis mystax (BI Schn)	Thryssa mystax	Engraulididae
32.	Engraulis setirostris	Thryssa setirostris	Engraulididae
33.	Hampala macrolepidota	Hampala macrolepidota	Cyprinidae
34.	Harpodon neherus (Ham Buck)		Stomiatidae
35.	Hemigobius bleekeri	Hemigobius bleekeri(Blkr)	Gobiidae
36.	Homaloptera wassinki	Homaloptera ocellata	Homalopteridae
37.	Homaloptera erythrorhina	Homaloptera ocellata	Homalopteridae
38.	Ketengus typus		Ariidae
39.	Kurtus indicus	Kurtus indicus	Kurtidae
40.	Morulius chrysospekadion	Labeo chrysophekadion	Cyprinidae
41.	Labeo erythropterus	Labeo erythropterus	Cyprinidae
42.	Lepidochepalus	Lepidochepalus	Cobitidae
43.	Luciosoma setigerum	Luciosoma setigerum	Cyprinidae
44.	Macrochirichthys macrochirus	Macrochirichthys macrochirus	Cyprinidae
45.	Macrognathus aculeatus	Macrognathus aculeatus	Mastacembelidae
46.	Macrones gulio	Mystus gulio	Bagridae
47.	Macrones micracanthus	Mystus micracanthus	Bagridae
48.	Macrones nemurus	Mystus nemurus	Bagridae
49.	Mastacembilus unicolor	Mastacembilus unicolor	Mastacembelidae

50.	Megalops cyprinoides	Megalops cyprinoides	Elopsidae
51.	Fluta alba	Monopterus albus	Synbranchidae
52.	Muraenesox talabon	Congresox talabon	Muraenesocidae
53.	Nemacheilus fasciatus	Nemacheilus pleifferae N.saravacensis	Balitoridae
54.	Oligolepis acutipennis	Oligolepis acutipennis	Gobiidae
55.	Ophiocara porocephala	Ophiocara porocephala	Eleotrididae
56.	Osteochilus hasseltii	Osteochilus hasseltii	Cyprinidae
57.	Osteogeneiosus militaris	Osteogeneiosus militaris	Ariidae
58.	Pangasius micronema	Pangasius micronemus	Pangasiidae
59.	Pellona dussumieri		Clupeidae
60.	Pellona elongata	Ilisha elongata	Pristigasteridae
61.	Periophthalmodon schlosseri	Periophthalmodon schlosseri	Gobiidae
62.	Platychephalus oligolepis Regan		Platycephalidae
63.	Platychephalus scaber	Grammoplites scaber	Platycephalidae
64.	Prionobutis koilomatodon	Butis koilomatodon	Eleotrididae
65.	Puntius aphya	Puntius aphya	Cyprinidae
66.	Puntius binotatus	Puntius binotatus	Cyprinidae
67.	Puntius bramoides	Barbodes balleroides	Cyprinidae
68.	Puntius leiacanthus	Puntius brevis	Cyprinidae
69.	Puntius javanicus	Barbodes gonionatus	Cyprinidae
70.	Puntius lawak	Kalimantania lawak	Cyprinidae
71.	Puntius platysoma	Puntius platysoma	Cyprinidae
72.	Rasbora vaillanti	Rasbora argyrotaenia	Cyprinidae
73.	Rasbora lateristriata	Rasbora sumatrana	Cyprinidae
74.	Setipinna melanochir	Setipinna melanochir	Engraulididae
75.	Setipinna taty	Setipinna taty	Engraulididae
76.	Sicyopterus masrostetholepis	Sicyopterus masrostetholepis	Gobiidae
77.	Siganus javus	Siganus javus	Siganidae
78.	Stigmatogobius sadanundio	Stigmatogobius sadanundio	Gobiidae
79.	Taenioides eruptionis	Taenioides cirratus	Gobioididae
80.	Tetraodon fluviatilis	Tetraodon nigroviridis	Tetraodontidae
81.	Trichiurus glossodon (Blkr)		Trichiuridae
82.	Trichiurus haumela (Forsk)		Trichiuridae
83.	Trypauchen vagina	Trypauchen vagina	Gobioididae
84.	Wallago attu	Wallago attu	Siluridae

Table 6. Fishes caught from the Brantas watersheds (especially Selorejo Area) in 1970. (Source: Wardoyo and Sukimin, 197.)

No	Species	Local name
1.	*Clarias batrachus* Linn.*	L e l e
2.	*Crossocheilus oblongus* (C.V.)*	B e j i n g
3.	*Cyprinus carpio* Linn.	T o m b r o
4.	*Glyptothorax platypogon* (C.V).	Tapal watu
5.	*Hemaloptera erythororhina* (C.V.).*	Kadalan
6.	Hemirhamphidae	Julung-Julung
7.	*Labeobarbus tambra* (C.V.)	Sengkaring
8.	*Lebistes reticulatus* Peters	G a t u k
9.	*Monopterus albus* Zuiew*	W e l u t
10.	*Nemacheilus fasciatus* (C.V.)*	U c e n g
11.	*Ophiochephalus gachua* (H.B.) *Channa gachua* (Kot.)	K o t e s
12.	*Panchax panchax*	Kepala Timah
13.	*Panchax panchax* (H.B.)	Wader gatul
14.	*Puntius binotatus* (CV)*	Wader cakul
15.	*Puntius javanicus* (Blkr)*	T a w e s
16.	*Rasbora sp.**	Wader pari
17.	*Tilapia mossambica* (Peters)	M u j a i r
18.	*Tylognatus falcifer* (C.V)	L e h a t

* Indigenous species of 1916-1962.

Comparing the two historical data, it can be noted that in 1970 there are only 8 fish types (indigenous species) which were caught as the species listed on the data of 1916-1962. Not many fishes data collected in 1970 because the study covered only on the middle area of the Brantas river.

The iventory data of the indigenous fish amount of the Brantas River is very lack, especially between 1970 and 1992. Presently there are only several studies or surveys about the amount of indigenous fishes of the Brantas river. The only survey was taken in 1993 by Susilo *et al.* (1993), whilst the other (Irfandi, 1997) studied the maturity sounding of *Pangasius micronemus*. Lack of researches caused lack of data and information about the decrease of the fish species in the Brantas river.

Present Status :

The existed epecies

During observation in dry and rainy season 1997, it has been found approximately 50 species. Among these species, 5 species could not be identified for their latin name, but its have been known by their local name. Some of these (18 species) are indigenous species of the Brantas River. The species existed in the Brantas River are shown on the Table 7.

Table 7. The existed species of the Brantas River in 1997.

No	Latin name	Local name	Family
1	*Achrochordonichthys rugosus*	Jogoripo	Akysidae
2	*Ambasis nalua*	Pengkih	Percomorphi
3	*Anabas testudinieus*	Betik, betok	Anabantidae
4	*Aplocheilus panchax*	Kepala timah	Cyprinodontidae
5	*Channa striata*	Kutuk	Channidae
	Channa lucius		
6	*Chanos chanos**	Bandeng	Channidae
7	*Clarias batrachus**	Lele lokal	Clariidae
8	*Clarias gariepinus*	Lele dumbo	Clariidae
9	*Cyclocheilichthys enoplos**	Wader	Cyprinidae
10	*Cyprinus carpio*	Tombro	Cyprinidae
11	Fam. Cobitidae	Seren	Cobitidae
12	*Glyptothorax platypogon*	Tapel watu	Sisoridae
13	*Hampala macrolepidota**	Palung	Cyprinidae
14	*Helostoma temmincki*	Keprek, Tambakan	Helostomatidae
15	*Ichthyocampus carce*	Sogoprono	Syngnathidae
16	*Labeo chrysophekadion**	Areng-areng	Ostariophyei
17	*Labeobarbus siamensis*	Sengkaring	Cyprinidae
18	*Macrognathus aculeatus**	Sili	Mastacembelidae
19	*Macrones gulio** (*Mystus gulio*)	Baung	Bagridae
20	*Macrones microcanthus** (*Mystus micracanthus*)	Keting	Bagridae
21	*Macrones pogulia*	Berot	Bagridae
22	*Macrones sp. (M. nemurus)*	Lenger	Ariidae
23	*Monopterus albus**	Welud, Welut, Belut	Flutidae
24	*Mystacoeleucus marginatus*	Bekepek	Ostariophyei
25	*Mystus nigriceps**	Bekel	

26	*Nemachilus fasciatus**	Uceng	Combitidae
27	*Ophiocephalus gachua* HB. *Channa gachua*	Kotes, Gabus	Channidae
28	*Ophiocephalus melanopterus (Channa melanopterus)*	Bekes	Channidae
29	*Osphpronemus goramy*	Gurame	Anabantidae
30	*Osteochilus haseltii**	Milem, Nilem, Bader muntu	Cyprinidae
31	*Osteochilus spilurus*		Cyprinidae
32	*Pangasius djambal*	Jambal	Pangasidae
33	*Pangasius micronemus**	Jendil/Wakal	Pangasidae
34	*Pangasius nasutus*	Mengkreng	Pangasidae
35	*Poecilia reticulata*	Ikan seribu	Poeciliidae
36	*Puntius binotatus**	Cakul, Gathul	Cyprinidae
37	*Puntius bromoides* (Barbodes balleroides)*	Bader bang	Cyprinidae
38	*Puntius javanicus (Blkr)* (Barbodes gonionatus)*	Tawes, Putian	Cyprinidae
39	*Puntius lawak* (Kalimantania lawak)*	Lawak	Cyprinidae
40	*Rasbora argyrotaenia* *	Wader pari	Cyprinidae
41	*Sukhermouth catfishes*	Suckermud, Cakarmut	Loricariidae
42	*Tilapia mossambiça (Oreochomis mossambicus)*	Mujair	Tilapidae
43	*Tilapia nilotica (Oreochomis niloticus)*	Nila	Tilapidae
44	*Trichogaster trichopterus*	Sepat	Belontiidae
45		Blancer	
46		Cetul	
47		Garingan	
48		Benculing	
49		Kebogerang	
50	nd	nd	
51	nd	nd	

* Indigenous species of 1962.
nd : undetermined

According to Weber and De Beaufort (1916-1962) there were 87 species of indigenous fish of the Brantas river. At present the amount of indigenous species decrease approximately to less than 30 % of the total species of 1916-1962. The decrease of the amount of indigenous species may be influenced by some factors :

1. Change of fish habitat naturally or by other factors.
2. The indigenous fishes fail in the competition with non indigenous species which came from other habitat.

3. Uncontrolled fish catchment.

4. Others: disease and water pollution.

The distribution.

Table 8a, 8b and 8c shows a low diversity of fishes in upperstream region. Upperstream area commonly has a low of water volume or of depth which may limited fish movement. It is also related to the primary producer or planktonic foods which are lower in this area.

Fishes distribution along the Brantas river shows a high diversity pattern in the middle part, especially in the reservoirs area or sites which are located near reservoirs, between Sengguruh, Ngembul and Kademangan. This pattern occurs up to Ngunut and Papar (Kediri), but tends to decrease in the basin areas.

Generaly as river size increasing, the number and diversity of fish species increasing too. The survey result in the Brantas river indicate that a higher diversity of "fishes food" in a large area (between the three big reservoirs of Sengguruh, Karangkates and Wlingi to Mojokerto) play an important role for this pattern. The decrease of species amount in Surabaya regency is caused by the presence of pollution, and only some tolerant fishes inhabit in this area.

The distribution patterns of fishes communities along the Brantas river remains not realy the same as the pattern of other river in the tropical region such as in the Gombak river, Malaysia, which has a highest diversity in the lower part. Other river like the Gombak (Bishop, 1973) shows a narrow width in the upperstream, and more wider to the mouth continually. According to Kottelat, *et al.*, (1993) factors which may influence this are the presence of plant material, the presence of a shading canopy which tends to reduce the abundance of benthic invertebrates beneath it but

increases the number of terrestrial invertebrates falling from it, and the distribution of riffles and pools.

The ecological differences which are seen from the head water to the river mouth such as changes in water speed, total volume of water, turbidity and substrate are also reflected in the distribution of fishes species.

Dry and rainy season catchment

In order to take a good data to compare the dry and rainy season data of the number of fish caught, it should catch the fish at the end of these two seasons. This year rainy season was initiated in the middle of November, so, the number of fish which was caught in the dry and rainy season in 1997 have no big different. Thus, to obtain the representative fish catchment amount between dry and rainy season, it was taken from fishermen's experience during several years live along the Brantas river.

Commonly, the number of catch by fishermen along the Brantas river in the rainy season is higher than in the dry season, because the river levels rise during rainy season. Higher level of water during and at the end of rainy season may facilitate the catchment.

This can also be explained by other study which was taken by McConnel (1969), he showed that some tropical fishes such as Cyprinoidea and Characnoidea breed only during high level of water volume. On the other hand, Irfandi (1997) has catch a high number of *Pangasius micronemus* (271 individus) from the Brantas during his study in November and December 1996. This is in accordance with catchment by fishermen in January and February, during this season many "little" fishes can be caught in the Brantas. *Pangasius micronemus* has a breeding time at the beginning of rainy season.

Table 8a : Fishes distribution in the Brantas river in 1997.

Species name			Sampling Sites													
No	Latin Name	Local Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*Achrochordonichthys rugosus*	Jogoripo						x								
2	*Ambasis nalua*	Pengkih							x	x						
3	*Anabas testudinius*	Betik, betok			x						x				x	
4	*Aplocheilus panchax*	Kepala timah									x	x	x			
5	*Brachyonus sp.*	Udang	x	x	x	x	x		x	x	x			x	x	x
6	*Channa striata/lucius*	Kutuk	x	x	x	x	x	x	x		x		x	x	x	
7	*Chanos chanos*	Bandeng												x		
8	*Clarias batrachus*	Lele lokal	x	x	x	x	x	x			x			x	x	
9	*Clarias gariepinus*	Lele dumbo	x	x	x	x	x	x			x					
10	*Cyclocheilichthys eneplos (Blkr)*	Wader	x	x			x	x			x		x			
11	*Cyprinus carpio (L)*	Tombro	x		x	x	x		x							
12	Fam.Cobitidae	Seren			x											
13	*Glyptothorax platypogon*	Tapel watu				x		x								x
14	*Hampala macrolepidota*	Palung			x	x	x	x								
15	*Helostoma temmincki*	Keprek			x		x	x								
16	*Ichtyocampus carce*	Sogoprono			x	x		x				x				
17	*Labeobarbus siamensis*	Sengkaring				x										
18	*Labeo chrysophekadion*	Areng-areng						x						x		
19	*Macrognathus aculeatus*	Sili				x	x	x	x					x		
20	*Macrones (Mystus) gulio*	Baung				x	x	x								
21	*Macrones pogulia*	Berot				x	x	x								x
22	*Makrones (Mystus) microcanthus*	Keting							x	x	x		x	x		x

Note : 1. Sengkaling, 2. Malang, 3. Sengguruh reservoir, 4. Ngembul 5. Kademangan, 6. Ngunut, 7. Papar, 8. Padangan, 9. Porong, 10. Canggu, 11. Gunung sari, 12. Hulu Wonokromo, 13. Wonokromo estuary, 14. Kali Gisik.

Table 8b : Fishes distribution in the Brantas river in 1997.

No	Species Name: Latin Name	Species Name: Local Name	Sampling Sites 1	2	3	4	5	6	7	8	9	10	11	12	13	14
23	*Mistus nigriceps*	Bekel				x	x	x								
24	*Mistacoeleucus marginatus*	Bekepek			x											
25	*Monopterus albus*	Welud Belut		x	x		x							x		
26	*Nemachilus fasciatus*	Uceng				x	x	x								
27	*Ophiocephalus gachua (Channa gachua)*	Kotes	x	x	x	x	x	x	x		x		x	x	x	
28	*Ophiocephalus melanopterus (Channa melanopterus)*	Bekes	x					x								
29	*Osphpronemus gorany*	Gurame				x	x		x							
30	*Osteochilus haseltii*	Milem, Mangut, Badermuntu, bayeman		x	x	x		x								
31	*Osteochilus spilurus*		x													
32	*Pangasius djambal*	Jambal						x						x		
33	*Pangasius micronemus*	Jendil/ Wakal				x	x	x	x	x						
34	*Pangasius nasutus*	Mengkreng				x	x	x	x							
35	*Poecilia reticulata*	Ikan seribu		x	x		x						x	x		
36	*Puntius binotatus*	Cakul, Gathul	x	x	x	x	x	x	x	x	x	x		x	x	x
37	*Puntius bromides (Barbodes balleroides)*	Bader bang			x	x	x	x	x		x		x	x	x	
38	*Puntius javanicus (Barbodes gonionatu)s*	Tawes, Putian			x	x	x	x	x		x					
39	*Puntius lawak. (Kalimantania lawak)*	Lawak				x	x									

Note : 1. Sengkaling, 2. Malang, 3. Sengguruh reservoir, 4. Ngembul 5. Kademangan, 6. Ngunut, 7. Papar, 8. Padangan, 9. Porong, 10. Canggu, 11. Gunung sari, 12. Hulu Wonokromo, 13. Wonokromo estuary, 14. Kali Gisik.

Table 8c : Fishes distribution in the Brantas river in 1997.

	Species Name		Sampling Sites													
No	Latin Name	Local Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14
40	*Rasbora argyrotaenia*	Wader pari			x			x	x							
41	*Suchermouth cuffishes*	Suckermud			x		x		x	x	x		x	x	x	
42	*Tilapia mossambica (Oreochomis mossambicus)*	Mujair		x	x						x		x		x	
43	*Tilapia nilotica (Oreochomis niloticus)*	Nila			x	x	x	x	x		x					
44	*Trichogaster trichopterus*	Sepat			x			x	x				x		x	
45		Benculing														
46		Blancer							x							
47		Cetul				x										
48		Garingan						x	x		x					
49		Kebogerang				x										
50		Lenger														x

Note : 1. Sengkaling, 2. Malang, 3. Sengguruh reservoir, 4. Ngembul 5. Kademangan, 6. Ngunut, 7. Papar, 8. Padangan, 9. Porong, 10. Canggu, 11. Gunung sari, 12. Hulu Wonokromo, 13. Wonokromo estuary, 14. Kali Gisik.

Other reason is increasing the number of fish from other tributaries or other area. According to Kottelatt (1993), some of the larger river fishes swim up small sidestreams and in some cases breed in this season. These visitors sometimes predatory exert pressure on the resident communities.

The turbidity caused by sedimentation in rainy season may disturb some fishes, but it does not last long. Some species are intolerant inhabit for long period in turbid water but many species have barbels to help sense movement and potential prey.

Indicator Species

In the polluted water where there are less oxygen content, some tolerant fishes can inhabit well because they have developed additional ways to absorb oxygen. Catfish (*Clarias*), gouramis and *Anabas* (and their relatives) have sac-like chambers above the gill cavity. These fishes are even able to travel overland, particularly on wet nights when there is little danger of drying out. Fishes seen in urban canals typically the tinhead, ikan kepala timah *Aplocheilus panchax*, *Poecilia reticulata* (ikan seribu) and *Oryziais javanicus* have superior mouths and flat heads. This allows them to take advantage of the oxygen-rich surface layer of the water without recourse to modified breathing organs. Scaleles fishes such as Periophthalmus are able to take up oxygen trough their skin. (Kottelat, et al., 1993).

Some fishes only inhabit commonly in clean water such as Cyprinus, can be classified as indicator of clean water. This species prefer a habitat having a high current velocity and water fall.

Based on these fishes characteristic, fishes from Brantas river can be grouped as can be seen in list below:

a. Indicator of clean water:

Cyprinus carpio

Nemacheilus fasciatus

bekepek

b. Indicator of polluted water:

Suckermouth

Clarias batrachus

Mystus microcanthus

Aplocheilus panchax

Poecilia reticulata

Tilapia mossambica

Monopterus albus

Some species are distribute widely from upperstream to the mouth of the river. These species consist of *Anabas, Puntius bramoides (Barbodes balleroides), Channa lucius, Puntius binotatus,* etc. Species which distribute widely from upperstream to the mouth generaly have a good adaptation to the environmental changement, but it is not a good indicator.

Keystone species and Endangerd species

The Brantas river has a popular species: *Pangasius macronemus* (local name: Wakkal (East Java) or Jendil (Center Java)) and is derived from family of Pangasidae. The fish is commonly found in the two long river in Java, the Bengawan Solo and the Brantas River. The different species of the same genera *Pangasius polyuranodon* occurs generaly in Sumatra (Djuanda, 1981). Naturally, it is originated from river which has a sluggish flowing water. In the past this species can be caught enormously but at present the amount of catch decrease.

Certain species, *Macrognathus aculeathus* or sili and *Ichtyocampus carce* are potential for aquarium fish trade. The two species although can be found in a several quantity but its were

hard to find. It is probably that the population in the Brantas river has been scarced. Other species which are found rarely are *seren*, *areng-areng*, *blancer* and *sengkaring*.

Some species are found only in a certain area of the river. *Nemachilus fasciatus* (uceng) and *Kalimantania lawak* (lawak) are indigenous species which are found only in the middle part of the river between Ngembul and Ngunut. Whilst the non-indigenous, *Labeobarbus siamensis* and *Glyptothorax platypogon* are endemic in the middle part.

Economic important fishes

Certain fishes such as wakal (*Pangasius micronemus*), Sengkaring (*Labeobarbus siamensis*), gurame (*Osphronemus guramy*), belut (Monopterus albus) and Gabus (*Channa gachua*) have an economic important because of their good taste. *Osteochilus haseltii* has an expensive price. *Chanos chanos* is cultivated in the brackishwater pond together with Penaeus in many coastal area in East Java. Culture of *Clarias* (lele) and belut (*Monopterus albus*) are taken place every where to meet many markets and restaurants demand. *Tilapia nilotica* (nila) and *Trichogaster trichopterus* (sepat) are also can be found in the market. Table 9 shows fishes, both of indigenous and non-indigenous of the Brantas river which have an important value.

Table 9. The important value of the indigenous and the non-indigenous fishes of the Brantas river.

Species	Local name	Value
*Clarias batrachus**	lele lokal	economic important, small-large scale culture
Clarias gariepinus	lele dumbo	idem
Cyprinus carpio	tombro	idem
*Monopterus albus**	belut	idem
*Chanos chanos**	bandeng	economic important, large scale culture in the brackish water ponds (tambak)
*Barbodes balleroides**	bader bang	economic important, non-

		cultured fishes
Channa gachua	gabus	idem
*Barbodes gonionatus**	tawes	idem
*Mystus nigriceps**	keting	idem
*Ostecheilus hasseltii**	bader munto	idem
*Nemacheilus fasciatus**	uceng	idem
*Pangasius micronemus**	wakal	keystone species, non cultured fish which has an economic value, prey of organic material
*Macrognathus aculeathus**	sili	potential for aquarium fish
Ichthyocampus carce	sogoprono	idem
*Rasbora argyrotaenia**	wader pari	idem

* indigenous species of 1962

Problems and target of fish biodiversity

Based on data of the past and present condition, some problesm and their solutions can be concluded.

1. Decreasing the number of indigenous species from 1962 to present.

This is caused by pollution, change of habitat naturally and by human activities, competition of indigenous fishes with the visitors, uncontrolled fish catchment, desease and pollution. Some solution can be suggested i.e. culture assay of indigenous species, habitat improvement, decreasing of source of pollutant, law enforcement for uncontolled fish catchment.

2. Lack of information and research for indigenous species and the fish ecological haracteristic and behaviour i.e. fish migration, food habit, spawning and its life cycle. More researches can be recomended.

3. Forest loss induce increasing turbidity in the water.

This may influence availabity of fish food and fish respiration. Reforestation and river bank rehabilitation can be undertaken to reduce these effects.

4. The reservoir function in the Brantas River Basin nowadays, are still not be used yet for the fish culture. The reservoirs are potential resources for increasing fish production in the province of East Java. It needs approach and coordination with the fishery official service of the Province of East Java (Dinas Perikanan Propinsi Jawa Timur) and other related institution, as the guidance and technical function in aquaculture. The PJT itself as "the owner" can invite the private sectors to share their investations on the fishery cultivation.

Fish culture in reservoir can be suggested using the floating net or the "karamba floating" system, which have been widely used succsesfully in certain reservoirs in West Java Province.

It also need the term of references or qualification fishery management, in older, the system do not become a disturbance for the water resources management by the PJT. By this way, the reservoirs can contribute the regional income.

5. Dam building without an ecological consideration for biodiversity. Fishes tend to migrate from one to another place, i.e. from one dam to another dam, thus, they need passage. Reservoirs in the Brantas river was constructed without fishes way. This may become an obstacle for fishes migration. The construction of dam should be equipped with fishes passage. The system such as fish traps or fish canals can be applied.

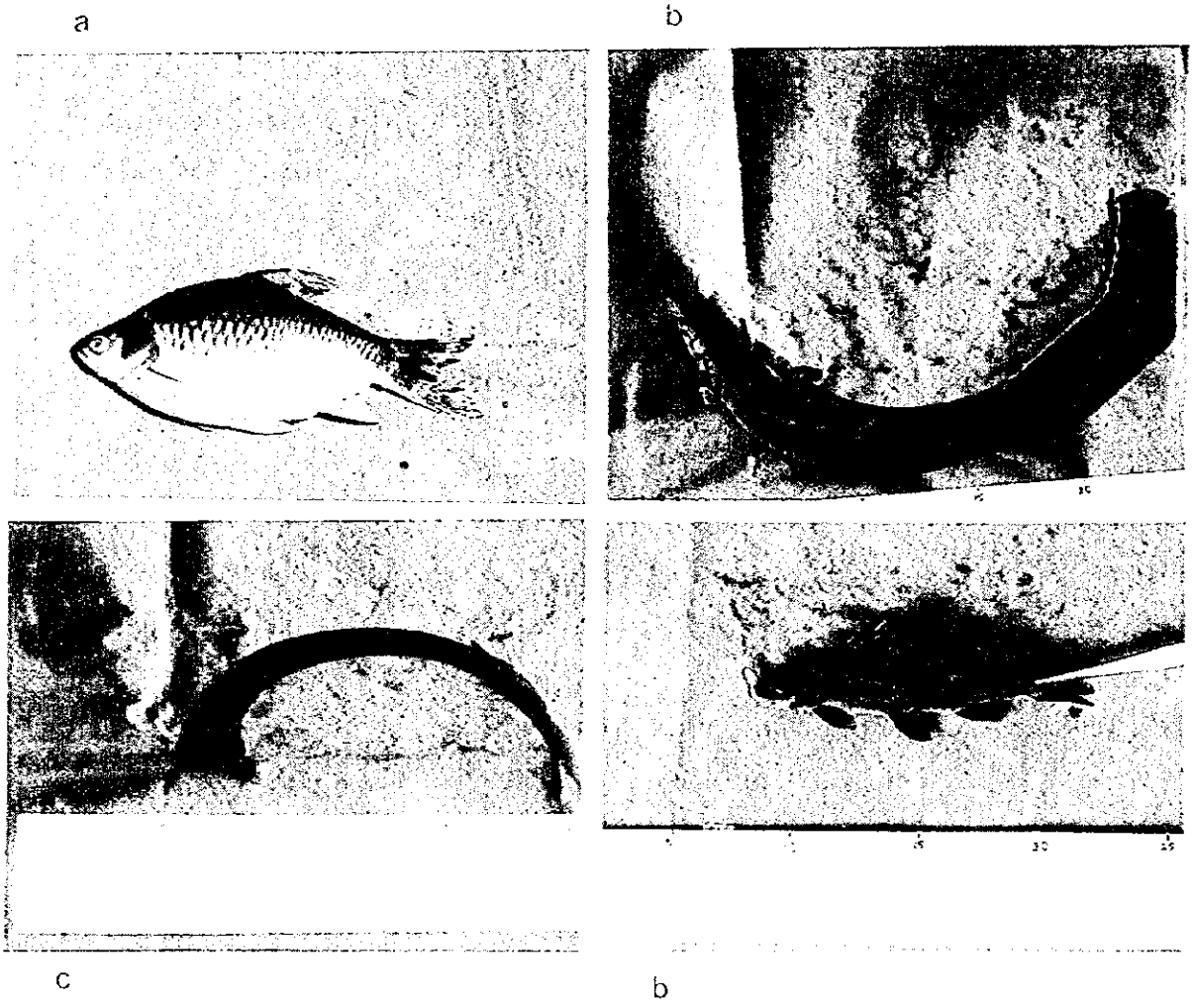
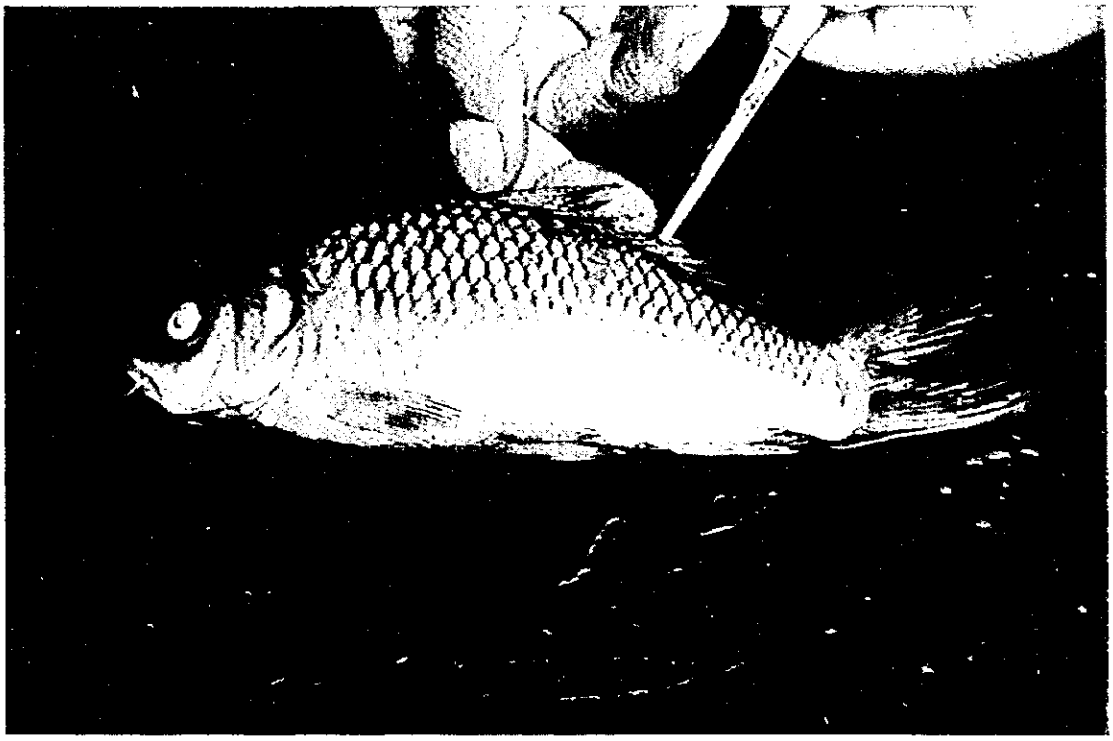
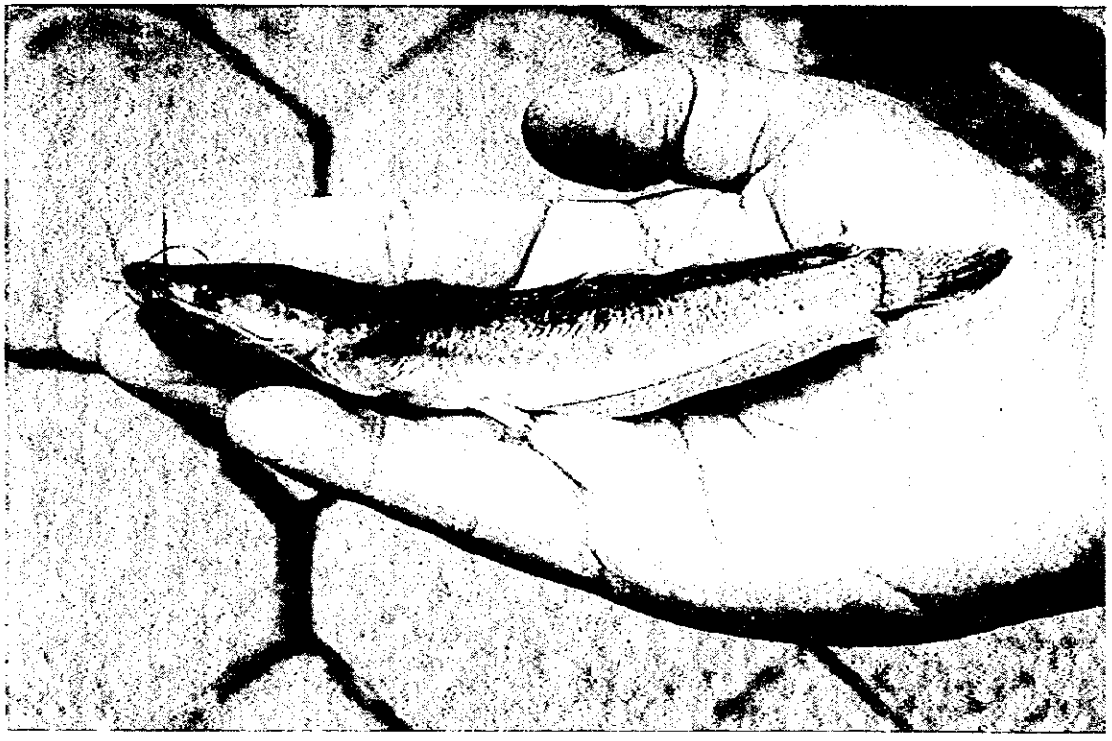


Figure 12. Some of the indigenous fishes of the Brantas River in 1997. (a). *Barbodes gonionatus* (*P. javanicus*, 'tawes'); (b). *M. gulio*, 'baung' (c). *Monopterus albus*, (d). *M. micracanthus* 'keting'. (Photos YR)

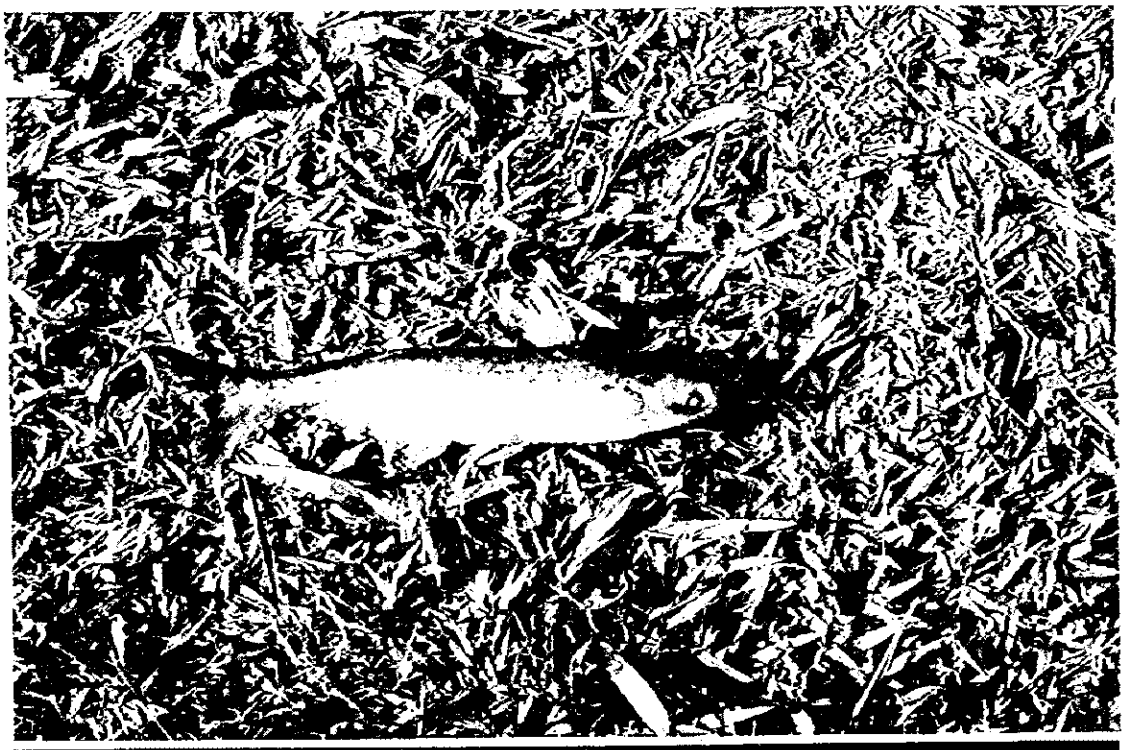


A



B

Figure 13. Some of the indicator species: *Cyprinus carpio* (A) a clean water species and *Clarias batrachus* (B) a polluted water species.(Photo: YR)



A

B

Figure 14. *Pangasius micronemus* (a), is the keystone and the indigenous species of the Brantas River; *Nemacheilus fasciatus* (b) is one of the indigenous species which has an important value. (Photos: YR)

BENTHIC MACROINVERTEBRATE COMMUNITIES

Present status:

the abundance

Benthic macroinvertebrate is organism that inhabit the bottom substrates (sediment, debris, logs, macrophytes, filamentous algae etc.) of aquatic habitats, for at least part of their life cycles. Macroinvertebrates are those retained by mesh sizes more than 200 to 500 um.

Benthic communities in the river occur from the upperstream part to downstream part with a different composition because of the different geographical condition and the availability of food of the river ecosystems.

The number of macroinvertebrate communities species at the Brantas river presents in Figure 15 for the dry season and for the rainy season.

Dry season

Figure 15 shows that during the dry season, the highest number of taxa occurs in Papar (21 taxa) while the smallest number occurs in Petekan (2 taxa). Papar is situated in the middle part of the Brantas river with a gravel substratum and fast current velocity. This condition constitutes a proper habitats for running water organisms, for instance, grazers and scappers. Most of gravel were covered by the benthic algae.

Petekan is situated in the downstream part of the Brantas river with the main land use is industrial activities. The type of substratum is commonly muddy with a sluggish current velocity forms habitat for dwelling organisms. This habitat is commonly consist of some dwelling organisms, for instance, molluscs and Tubificidae. Not many macroinvertebrate occurs in the muddy substratum due to not all the macroinvertebrates have tolerance to organic pollution.

Figure 15 also shows that the number of taxa in the upperstream part, for instance, in Junggo and Sengkaling are lower than in Papar. This is may be caused by the different level of taxon. Canggu is an exception. It is situated in the downstream part of the Brantas river with gravel substratum and a fast current velocity. Most of macroinvertebrates occurs in Canggu are typically running water organism, for instance, *Baetis sp*. This is caused by the slope of the river bed in Canggu area which is relatively steep.

In general this Figure shows that the number of taxa in the upperstream part is higher than in the downstream part. This phenomenon commonly occurs in the river. It is related to the fact that the influence of human activities in the upperstream part is lower than in the downstream part.

Rainy season

The highest number of taxa (19 taxa) occurs in Sengkaling in the upperstream part of the Brantas river while the lowest taxa (1 taxa) occurs in Gunungsari in the downstream part (Figure 15).

Sumber Brantas which is situated in the source of the Brantas river has a high number of taxa. The availability of food is not only from allochtochnous source but also from autochtonous source. The springs has no shading along approximately a length of 4 m, so benthic algae grows at the surface of stone to provide food for the macroinvertebrate communities.

Junggo which is situated for about 4 km from Sumber Brantas has still clean water. The type of substratum is a combination of cobble and gravel, the water has a fast current velocity. A number of taxa macroinvertebrate occurs here with a high abundance. It seems that in the early of rainy season, the abundance of macroinvertebrate in both Sumber Brantas and Junggo is not influenced yet by the ecology of the stream.

In Sengkaling, the river is already turbid because of agricultural activity (vegetable) in the upper land. Despite of this, the site has fast currrent velocity with a combination of cobble and gravel substratum to make it a proper habitat for macroinvertebrate.

Malang which is situated in the upstream part has a low number of taxa. It is composed by organisms which tolerate to organic pollution, for instance, Tubificide. As it is indicated in the earlier chapter, the water river at this site has been polluted due to human activities.

In the middle part of the river, the highest number of taxa (13 taxa) occurs in Kademangan. This site is situated after several reservoirs (Sengguruh, Karangkates, Wlingi and Lodoyo) that makes the water flow in Kademangan is a well aerated. The type of its substratum is a combination of gravel and sandy. It has a fast current velocity. The main landuse in this place is agricultural and settlement area and there is no industrial activities. Looking at the situation of the Brantas river from the source to the mouth, Kademangan can be considered as a recovery area of the Brantas river. Further research is needed to support this statement.

Canggu in the downstream part of the Brantas river in Mojokerto city has still high taxa number. This is due to the environmental factors which support them to inhabit there. In general it seems that the number of taxa in the upperstream part is higher than in the downstream part, similar to the dry season.

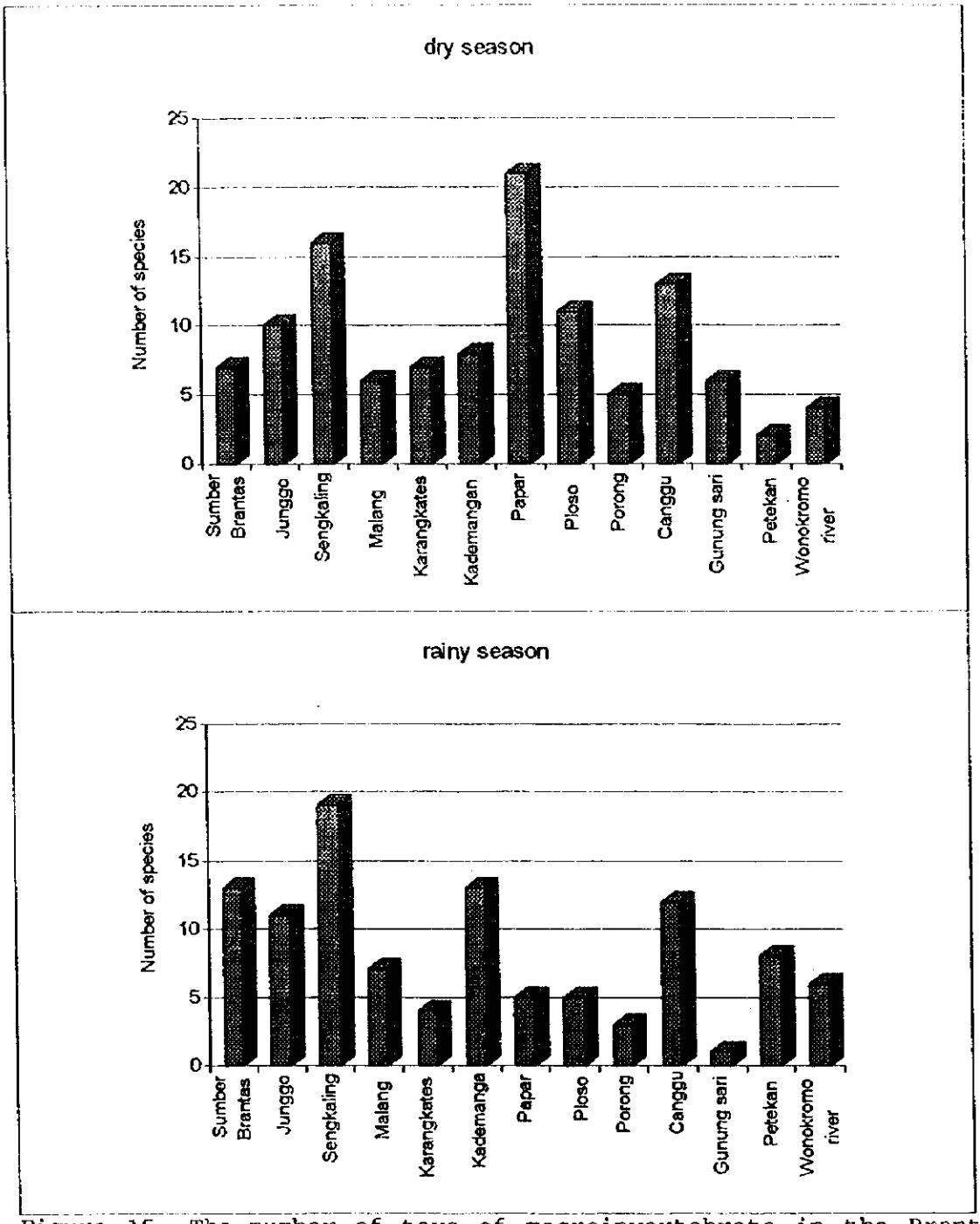


Figure 15: The number of taxa of macroinvertebrate in the Brantas River during the dry and the rainy season 1997.

The role of Macroinvertebrate communities at the Brantas river ecosystem.

1. Energy transfer within macroinvertebrate communities and their ecosystems.

Macroinvertebrate communities at the Brantas river may describe energy transfers within communities and ecosystems. The presence of macroinvertebrate communities is related to the availability of Benthic algae as a food source and the dead leaves as the coarse organic material. Benthic algae can grows due to the presence of nitrate and orthophosphat concentration of the stream. Mean while nitrate and orthophosphat originate from both autochtonous and allochtochous source. The sampling site of the Sumber Brantas is a confluence between the Sumber Brantas's source and the Sumber Gondo's source. Sumber Gondo itself contributes nitrate and orthiphosphat from agricultural activity.

In Junggo the biodiversity of macroinvertebrate is higher than in Sumber Brantas. On the basis of an interview with the local people, in Junggo there was some fishes, *Ophiochepalus* (kotes) which are found at the past in 1993. It is now already gone because of uncontrolled fish catching using potas as a kind of toxic material. From the source to the mouth of the composition of macroinvertebrate communities at the Brantas river may be related to the availability of organic material as food source from coarse organic materials in the upperstream part to fine organic materials in the downstream part and some predators (fish).

2. Macroinvertebrate communities has a role in self purification.

Macroinvertebrate communities is a heterothropic organisms. they are dependent on organic material in the river ecosystems. They reduce the organic content in the river bed. So, it is very important to sustain their habitat for instance stone, gravel, and sandy remain in the stream in order to conserve them. They can

reduce the organic content in the river bed. The highest taxa occurs in Kademangan, Papar and Ploso. it may be caused by macroinvertebrate activities in feeding habit in the river. those are seemingly to be a recovery area.

The problems and the solutions

Macroinvertebrate communities in the Brantas Rifer facing some problems:

- The changing of the original habitat due to afforestation. This activities causes erosion which maybe effects the type of substratum from hard substratum to soft substratum, consequently the composition of macroinvertebrate communities will change from running water organisms to dwelling water organisms. The loss of forest may influence the organisms because they depend on leaves for their food.
- Sand digging.

Sand digging damages the habitat of macroinvertebrates which exist in the sandy substratum, for instance Caenis and some Trichoptera.

- Pollution from industrial waste and agricultural activities.

The solutions for the problems cited above are: controlling forest land, sand digging monitoring and improving waste water treatment for domestic and industrial waste.

<u>Threat for biodiversity conservation</u>

The sustainable of macroinvertebrate communities depend on the availability of substrat to live. Substrat is the main habitat for them, because they live sedately. Removing stone, gravel and sand from the river will dissappear their habitat. Consequently, macroinvertebrate cannot live , and fish, particularly some carnivora, in turn, can not survive in the river. This may be caused by the decreasing of fish biodiversity at the Brantas river. Another factor which influences the composition of

macroinvertebrates is erosion from terrestrial. It may changes the type of the substratum from a hard sustratum to a soft substratum.

Target: Macroinvertebrate communities as a tool of aquatic resource management.

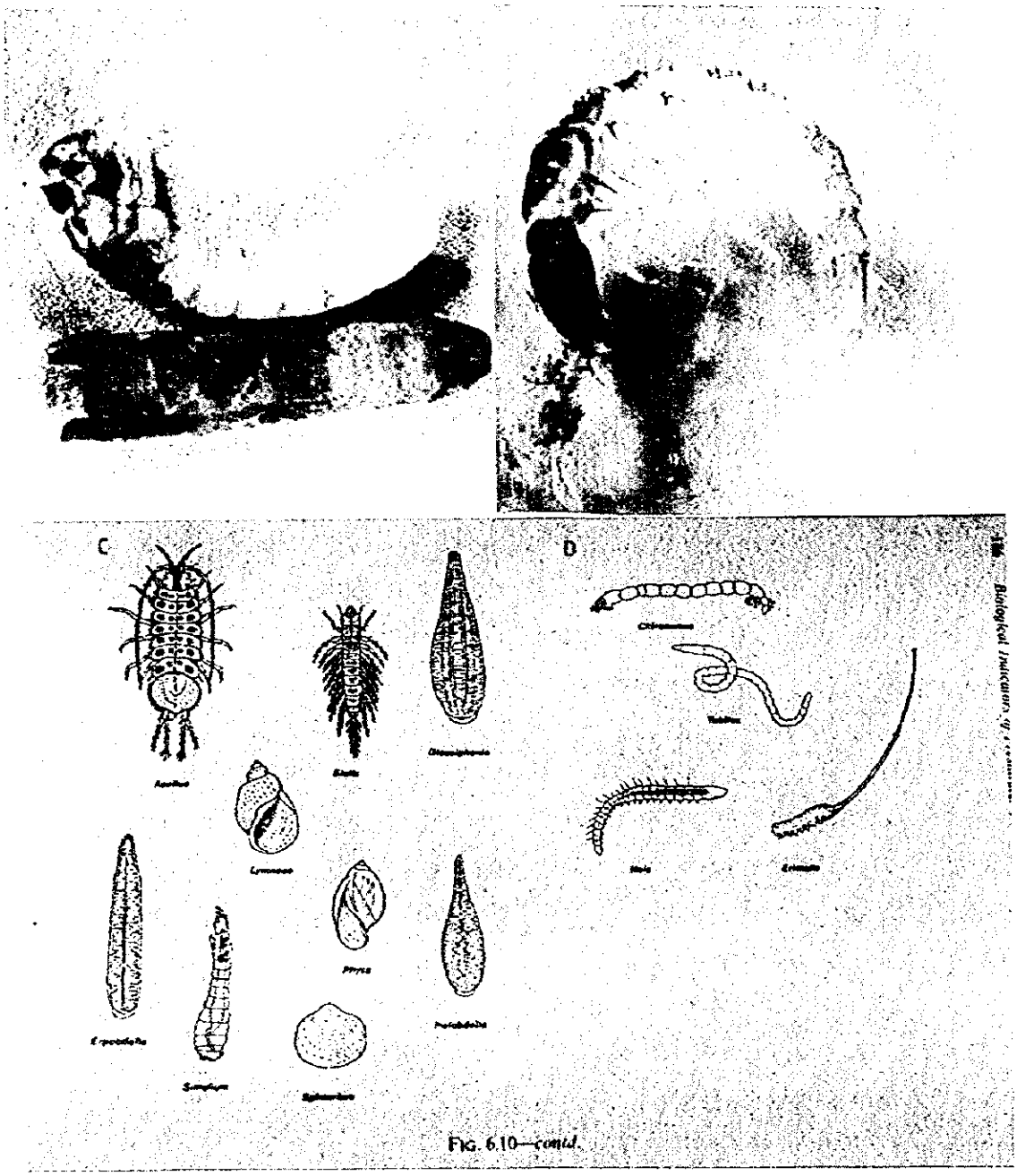
Macroinvertebrates occur in whole of the Brantas river from the source to the mouth. They comprise different groups related to organic pollution, namely: a sensitive, a moderate, and a heavy organic pollution. A sensitive group, for instance, member of Plecoptera; a moderate group, for instance, member of Hydropsychidae, while a tolerance group, for instance, Tubificidae and *Chironomous thummi* (Sudaryanti, 1992-1997).

The use of macroinvertebrate as biomonitoring has an advantage than physico-chemical approach. They are immobile and have a long life cycles so their presence in the streams may reflect their environment. While using a physico-chemical approach, it needs an expensive equipment and a high cost and the result can not describe the current condition because the water is dynamic (undirectional). Macroinvertebrates has a role function as a natural monitoring. This approach is useful for the natural conservation.

In Act No 20/1990 regarding the water pollution control, the use of biological approach is not developed yet. Macroinvertebrate communities is an alternative for the aquatic resource management particularly in the river.

To set these targets some programs can be done, such as, revegetation of river bank, habitat improvement, fish stocking particularly the omnivore fishes in the downstream part of the Brantas river and law enforcement.

a b



c

Figure 16. Some example of macroinvertebrate species commonly found in clean water (a & b) and in polluted water (c).(Repro: YR, source from Hellawell, 1986 and Nuffic).