PHYTOPLANKTON CHANGES IN SOME INLAND WATER HABITAT OF CENTRAL KALIMANTAN, INDONESIA

Sulastri✉ and Dede Irving Hartoto

Research and Development Center for Limnology, Indonesian Institute of Sciences,
Kompleks LIPI Cibinong, Jl Raya Bogor-Jakarta Km 46, CIBINONG-BOGOR, 16911.
Ph. 021-8757071 Fac: 021-8757076, E-mail: limno@indo.net.id

ABSTRACT

The changes in the density, number of genera, diversity index of phytoplankton in some oxbow lakes (Lake Rengas, Lutan, Takapan) and lowland lake (Lake Sembuluh) are described. Phytoplankton samples collected in rainy season, dry season (1995 to 1997) and in the forest fire period (October 1997). Before forest fire period, most of the time the density of phytoplankton was high (489 to 759 individuals/1) in January or rainy season especially in oxbow lake system. The high number of phytoplankton in rainy season is not common in the standing water in the floodplain system. This is probably because of the type of water that is acid water with the pH (4.43 to 4.66) in Lake Rengas, Lake Lutan (4.93 to 5.93) and Lake Takapan (4.03 to 4.64). In acid water oxbow lake, only some certain species occurred in the dry season. In January (rainy season), the inputs of water from main river increase the pH and presumably also nutrient, as shown by higher conductivity. In Lake Rengas, the highest density found in June that dominated by one genera (Oocystis). These facts probably because of phytoplankton input from the river Rungan that also show high density of the same species. It is also showed that the number the number of genera is also high in rainy season. Nonetheless of index diversity changes is not clear. In October 1997, when the forest fire period the density of phytoplankton and some genera as a group of Euglenophyceae increased. The highest density was found in Lake Sembuluh that range from 10,507 to 39,536 individuals/1. The phytoplankton density of Lake Rengas, Lutan and Takapan are 3,254, 1,414 and 9,019 respectively. The relationship of forest fire to the phytoplankton density is briefly discussed.

Keywords: Phytoplankton changes, diversity index, inland water habitat, oxbow lake, lowland lake, forest fire, Central Kalimantan.

INTRODUCTION

The area of wetland in Central Kalimantan was reported about 1,932,000 hectare (ha) which grouped into freshwater swamp 940,000 ha, Peat swamp 872,000 ha, mangrove forest 100, 000 ha and freshwater lake 20,000 ha (Sylvius, 1986). The several of inland water habitat as separate ecosystem with characteristic vegetation type or plant and animal species. These inland waters habitat are important resources for local people in Central Kalimantan, however the information of the inland water ecosystem in this area is limited. Lake and freshwater ecosystem in Kalimantan are important source of fish for local communities and the main supplier of dried freshwater fish export to Java. In 1985 19000 tons of dried fish was exported to Java and 3000 ton come from Central Kalimantan (Me. Kinnon, 1986).

Phytoplankton plays important role in the inland water ecosystem, virtually the dynamic of the lake such as color, clarity; trophic state or animal plankton and fish production depends large degree on the phytoplankton (Goldman & Home, 1998). In the meanwhile phytoplankton growth is affected by environmental condition, like transparency and some physical and chemical water quality parameters. Therefore phytoplankton respond to their environmental characteristic fluctuation like water level, light intensity, water temperature, conductivity, pH or climate changes.

This study was conducted to elucidate the fluctuation pattern of phytoplankton in relation with the environmental changes.

Study area

The study was conducted in some oxbow lakes including oxbow lake that receive water from a main river (Lake Lutan), oxbow lake that receive water from a tributary river (Lake Rengas), oxbow lake that receive water both from a major river and tributary river (Lake Takapan) and a lowland lake (Lake Sembuluh). The position and the description of sampling site are presented in Table 1 and Figure 1.

MATERIAL AND METHODS

Phytoplankton samples were collected in the rainy and dry season between 1995 and 1997 and in the forest fire period in 1997. It was reported that dry season period in the study area in 1995 , 1996 and 1997 are the first week of June to the third week of October; the first week of June to the third week of September and the first week of June to the third of September (Anonymous 1995, 1996 and 1997). To have representative data, the data was collected in at least two or four sampling points at each inland water habitat. In oxbow lakes the data was collected in the pelagic zone but in Lake Sembuluh, the data was collected both in pelagic and littoral zone. Temperature, conductivity, maximum depth, Secchi depth transparency, turbidity, pH, dissolved oxygen were measured *in situ* using Horiba U-10 instrument. Water sample was collected in acid-PVC flasks and analyzed in Aquatic Dynamics Division laboratory, Research and Development Center for Limnology. Phytoplankton samples were collected by taking the water with Van Dorn sampler from the surface water, the middle or column water and the bottom of water until 30 liters then filtered with plankton net number 25 and mesh size of nylon 40 urn. Phytoplankton was fixed in 1 % Lugol solution for identification in the laboratory. The alga taxa were identified according to Prescott (1970) and Scott and Prescott (1961). Quantitative analyses of phytoplankton are conducted using the binocular microscope and accounted with Lackey Drop Microtransect Method (Anonymous, 1977). Species diversity indices were calculated according to Shannon and Weaver formula presented in Odum (1971).

RESULTS AND DISCUSSION

The study sites show acid condition, low conductivity and low dissolved oxygen concentration (Table 2). It is shown that this area has low productivity. Lake Lutan has higher pH and conductivity compared to Lake Rengas and Takapan. Lake Lutan receives the water only from main river (River Kahayan) so the water quality is affected by River Kahayan water that has higher pH and nutrient. The study site also has low Secchi Depth because of this area is backwater area. Generally in oxbow lake system (Lake Rengas, Lutan and Takapan) pH and conductivity increase when water level increase in rainy season especially in January or November. It seems that in the rainy season, the input of water from connecting river into oxbow lake increase the pH and presumably also nutrient, as shown by higher conductivity (Table 2). In October 1997 pH and conductivity also increase both in oxbow lake system and Lake Sembuluh (Table 2 and Table 3). During this month there occurs a haze period due to extensive forest fire in the long dry season (El Nino period) so it probably gave an impact to the water quality because of input any gases like CO_2 and mineral from the ash of the forest fire.

Before forest fire period, the density of phytoplankton was high in January or rainy season, with the range 443 individual s/1 to 759 individuals/1 especially in oxbow lake system (Lake

Rengas, Lutan and Takapan). This high number of phytoplankton in rainy season is not common in standing water of floodplain system as in Kahayan River system. Studies on floodplain lagoon from Africa showed that phytoplankton density tends to reach a peak in the dry season and diminish in the floods (Welcome, 1979). Furthermore he reported that this pattern is not universal as in Amazon River system because of interaction between the various water types in this river. Marlier in Welcome (1979) gave an example as in Lake Redondo, the peak of alga production was reached during the raising water when the nutrient rich from Whitewater were invading the lagoon. It seems that this pattern was also found in this study, when the water level increase in January the water with the rich nutrient and higher pH from River Kahayan invaded the oxbow lake as shown by higher conductivity and pH in this month (Table2). The highest nutrient especially nitrogen was found in rainy season or November and in January still high concentration compared to dry season or July. In lake Lutan, Takapan in November were 11.068; 12.839 and 10.638 mg/1 respectively. In January concentration of nitrogen in Lake Lutan, Rengas and Lake Takapan were 4.489, 5.386 and 5.198 mg/1 while in dry season or July were 2.034, 1.706 and 1.261 mg/1 respectively. Concentration of phosphorous seems not different between dry and rainy season.

During forest fire period (October 1997) phytoplankton changed significantly either the composition or the density especially in Lake Lutan, Takapan and Sembuluh (Table 5, Table 6 and Table 7). As mention above, during forest fire period probably there were some inputs of gas like CO_2 or minerals into the water, which give impacts to the water quality and increase phytoplankton density.

The average of phytoplankton density in Lake Rengas is 2894 individuals/1 with the minimum density is 75 individuals/1 in March and maximum density is 17603 individuals/1 in June 1997. In Lake Lutan average density of phytoplankton is 358 individuals/1 with the minimum density is 106 individuals/1 in May and maximum density is 1414 individual/1 in October 1997. In Lake Takapan, the average density of phytoplankton is 1229 individuals/1 with the minimum density is 94 individuals/1 in June and maximum density is 9019 individuals/1 in October 1997. In Lake Sembuluh, the average density of phytoplankton is 169 individuals/1 in October 1995, 249 individuals/1 in October 1996 and 22145 individuals/1 in October 1997.

The average of phytoplankton density in Lake Lutan is lower than other sites, although the pH and conductivity also high in this site. What mechanisms that actually control the phytoplankton density in this oxbow lake is subject for further study. However, in Lake Lutan diversity index and number of genera are the highest . During forest fire period, the density of phytoplankton in Lake Lutan is not so high. This condition also gives an impact on the average value of phytoplankton in this lake. Most of the time the highest density was found in October 1997 when forest fire occurred. The highest density was occurred in Lake Sembuluh. The highest density of phytoplankton in Lake Sembuluh probably related to the area of forest fire in this site.

It is shown in Table 8 that Chlorophyceae is the common dominant genera both in the oxbow lake system (Lake Rengas, Lutan and Takapan) and in Lake Sembuluh. The high density was occurred in November 1996, January and October 1997 or during forest fire period. It is probably due to increasing nutrient from the river when water level increases in rainy season and from ash of forest fire. The highest density of Clorophyceae was also found in June 1997, however the highest density was only found in Lake Rengas that dominated by genera of *Oocystis* (Table 4). The highest individual number belongs to genera *Oocystis* in this lake seems influenced by River Rungan as the water source of lake Rengas. Because the same genera *Oocystis* was also found high density in Lake Rengas. The dominant genera of Chlorophyceae in rainy season are *Oedogonium; Trochisia* and some genera belong to group of desmid such as *Closterium, Gonatozygon* and *Pleurotaenium.* During forest fire period in October 1997 the composition of Chlorophyceae was change significantly especially in Lake Takapan and Sembuluh (Table 6 and 7). Some genera like *Crusigenia, Kirchneriella* and *Scenedesmus* that rarely found before, become high density in forest fire period. In Lake Sembuluh group of desmid such as *Cosmarium, Arthrodesmus,* and *Closterium* become dominant during forest fire period. The other group that rarely found in Lake Sembuluh becomes high in density during this period such as *Dimorphococus, Dictyospaerium, Kirchneriella* and *Spirogyra.*

Bacillariophyceae is fairly common genera in Lake Rengas, Lutan, Takapan and Sembuluh. The highest density is in August 1995 (dry season), January 1997 (rainy season) and October 1997 (forest fire period). The high density of Bacillariophyceae in August or dry season probably due to the colonization or establishment by certain species that can adapt to environmental changes such as nutrient or water quality. A few genera were found from this group however the density was high in this season. The dominant genera in this month are *Nitzschia* and *Navicula.* The high Bacillariophyceae in January probably related with input of this group from the main river when the water level increased and invaded into the backwater (oxbow lake). It was reported that that the main river was inhabited mainly desmids and diatoms (Welcome, 1979). The occurrence of high of Bacillariophyceae density in October 1997 probably due to increasing of nutrient because of forest fire.

Cyanophyceae is relatively poor or the third dominant genera in Lake Rengas, Lutan, Takapan or Sembuluh. The highest density of Cyanophyceae is in October and November 1996 and October 1997. This phenomenon is probably due to impact of nutrient input from watershed in start of rainy season and from forest fire. *Anabaena* is common genera in Cyanophyceae.

Chrysophyceae, Dynophyceae and Euglenophyceae are poorly genera presented in Lake Rengas, Lutan, Takapan and Sembuluh. The high density of these groups only found in October 1997. It is probably related with environmental changes such as nutrient, pH or other parameters because of forest fire. It was reported that Euglenophyceae, Dinophyceae preference to grow in water with higher pH and Chrysophyceae are common for higher conductivity (Malatoni and Tell, 1996). In this study site, data shows that pH and conductivity increase in October 1997. The Chrysophyceae only consist of one genus *Dinobryon* while the genera that belong to group of Dinophyceae are consisted of *Peridinium* and *Glenodinium.* The group of Euglenophyceae consists of three genera *Euglena, Phacus* and *Trachelomonas.*

Index diversity of phytoplankton show a different pattern (Table 9), as in Lake Rengas the highest of index diversity is in August, in Lake Lutan is in September and November 1996 and in Lake Takapan in June and October 1997. It is probably because of different type of habitat between this oxbow lake so it gives different in abundance of phytoplankton and genera number is highest than other oxbow lake. As mention above, it seems that it had a relationship with the pH and conductivity values that was highest compared to other station. In Lake Sembuluh the index diversity of phytoplankton was high in October 1997 or during forest fire. It also shown that phytoplankton changes significantly in time, both in the density and number of genera. It also caused the index diversity of phytoplankton high in this month.

CONCLUSION

Before the forest fire period, most of the time the density of phytoplankton was high in January or rainy season that range 489 to 759 individuals/1, especially in oxbow lake system. During the forest fire period, the composition and density of phytoplankton change significantly. Some genera rise and the density increased, as groups from Euglenophyceae in this period. During forest fire period, the highest density was found in Lake Sembuluh that range 10,508 to 39,536 individuals/1. The densities of Lake Rengas, Lutan and Takapan are 3,254, 1,414 and 9,019 individuals/1 respectively. The pattern of index diversity changes is not clear especially in oxbow lake system. In Lake Sembuluh, the index diversity was high during the forest fire period.

REFERENCES

Anonymous. 1975. *Standard Methods for the Examination of Water and Wastewater.* 14th. Edition. APHA-AWWA-WCF.

Goldman CR and Home AJ. 1983. *Limnology.* McGraw Hill Book Company, London, Mexico, Sidney.

Mac Kinnon K, Hatt G, Halim H and Mangalik A. 1996. *The Ecology of Kalimantan.* The Ecology of Indonesian Series. **Volume III.** Periplus Edition (HK) Ltd. Singapore.

Mataloni G and Tell G. 1996. Comparative Analysis of the Phytoplankton Communities of a Peat Bog from Tierra Del Fuego (Argentina). *Hydrobiologia* **325,** 101-112.

Odum EP. 1971. *Fundamental of Ecology.* 3rd Edition. WB Sounder. Philadelphia.

Prescott GW. 1963. *The Freshwater Algae,* WM Brown Company.

Scott ANM and Prescott GW. 1961 *Indonesia Desmids. Hydrobiologia* **XVII, 1-2. Dr W** Jung, Den Haag.

Silvius MJ, Djuharsa E, Taufik AW, Steeman APJM and Berchy ET. 1986. *The Indonesia Wetland Inventory. A Preliminary Compilation of Information on Wetland of Indonesia.* PHPA-AWB/ INTERWADER EDWN **Vol. II.**

Welcome RL. 1979 *Fisheries Ecology of Flood-plain Rivers.* Longman. London and New York.

Table 2. The water quality data of Lake Rengas, Lutan and Takapan.

Parameters	Jul. 95	Sept. 95	Oct. 96	Nov. 96	Jan. 97	Mar. 97	Apr. 97	May 97	Jun 97	Oct. 97
Lake Rengas										
Depth (m)	4.5	*	*	5.31	6.7	4.00	2.00	3.00	3.00	2.500
Secchi (cm)	80	*	*	45	38	28	41	39	33	41
Turbidity (NTU)	10	*	*	38	21	24		13	28	32
Water temperature (°C)	28.7	*	*	26.3	29.7	28.6	28.5	28.2	30.8	27.2
Conductivity (mS/cm)	0.011	*	*	0.008	0.010	0.009	0.005	0.006	0.004	0.006
pH	4.43	*	*	4.16	4.65	4.65	4.53	4.52	4.66	5.47
DO (mg/1)	5.44			6.25	3.5	4.00	5.00	3.00	3.00	2.50
Tota\ N (mg/V)	\.706	•	5.386	12.839	5.866	1.815	*	*	*	*
Total P (mg/1)	0.127	*	0.279	0.259	0.208	0.117	*	*	*	*
Lake Lutan										
Depth (m)	1.60	2.25	*	3.00	3.30	1.00	2.00	2.00	1.00	0.50
Secchi (cm)	82.0	52.0	*	49.0	31	34.0	20.8	33.2	23	21.8
Turbidity (NTU)	10	99	*	56	117	76	102.3	65.2	78	90.
Water temperature (°C)	27.3	29.9	*	27.1	28.2	30.6	26.9	29.1	29.1	28.5
Conductivity (mS/cm)	0.013	0.018	*	0.019	0.025	0.023	0.007	0.019	0.017	0.036
PH	5.74	4.93	*	5.50	6.26	5.38	5.43	5.48	5.82	6.34
DO (mg/1)	5.63	2.61	*	4.34	2.59	4.34	4.01	1.8	2.29	4.0
Total N (mg/1)	2.034	*	2.387	11.068	4.489	5.522	*	*	*	*
Total P (mg/1)	1.131	*	0.359	0.218	0.195	0.131	*	*	*	*
Lake Takapan										
Depth-(m)	4.5	5.02	4.0	*	*	6.8	*	*	*	3.5
Secchi (cm)	48.8	44.5	37	*	*	53.7	35.4	37.8	13.0	62
Turbidity NTU)	31.3	40.2	55	*	*	31	48.1	80	89.8	13.5
Water temperature (°C)	29.4	26.7	26.7	*	*	33.6	27.7	27.5	28.6	27.9
Conductivity (mS/Cm)	0.005	0.011	0.005	*	*	0.003	0.004	0.003	0.006	0.014
PH	4.54	5.89	4.03	*	*	4.96	4.46	4.10	4.62	5.76
DO (mg/1)	2.08	3.76	1.17	*	*	3.41	3.58	2.74	1.12	3.45
Total N (mg/1)	1.261	*	3.505	10.638	5.198	3.158	*	*	*	*
Total P (mg/1)	0.130	•	2.272	0.263	0.185	0.127	*	*	*	*

Note : * missing data

Table 3. The water quality data of Lake Sembuluh.

Parameters	Sampling sites								
	Oct95			Oct. 96			Oct. 97		
	TB	BM	PEL	TB	BM	PEL	TB	BM	PEL
Depth (m)	2.2		4.5	1.5		3.9	2.00		
Secchi (cm)	167	148.5	172.3	110.5	88	111.1		35	28
Turbidity (NTU)	5.6	4.2	5.5	8.7	10	8.3	26	36	34
Water temperature (° C)	31.4	31.3	29.8	30.1	29.4	29.6	27.0	26.0	27.2
Conductivity (mS/cm)	0.008	0.007	0.006	0.005	0.005	0.002	0.001	0.012	0.013
PH	4.9	5.02	4.98	4.39	4.32	4.18	5.27	5.31	4.9
DO (mg/1)	2.5	6.76	6.94	3.93	4.07	5.58	5.76	5.23	5.42

"IB: Gulf of Telaga Bintang; BM: Gulf of Batu Menangis; PEL: Pelagic habitat of Lake Sembuluh

Table 4. Genera of phytoplankton observed in Lake Rengas

Group	Sampling time							
	Augst.95	Nov. 96	Jan. 97	Mar. 97	Apr. 97	May 97	Jun. 97	Oct. 97
Cyanophyceae								
Anabaena		7	7	17	10	6	112	
Aphanizomenon	3							
Aphanocapsa			13					
Chroococcus			3			12		
Holopedium		2						
Lyngbya		9						
Merismopedia								4
Microcaete		7						
Microcystis			3	9				
Nostoc		11				6	3	
Nodularia			3					
Oscillatoria		13	4					
Phormidium	5							
Spirulina				2				
Chlorophyceae								
Actinastrum								14
Ankistrodesmus	3	16					3	14
Arthrodesmus								6
Basicladia		2	2					
Chlamidomonas				1				
Cladophora			13			540	3	
Closterium	:25	202	100	1		12	3	45
Cosmarium			7					1
Crucigenia								9
Desmidium	5	9						
Exentrosphaeria				2				
Gonatozygon	19	3g	4	2			3	
Kirchneriella			gp	2		2		
Lagerhemia								
Microspora			27					
Meugotia	14					2		
Oedogonium			211					
Oocystis					153	2	17500	14
Pediastrum					70			
Pleurotaenium								4
Richtrella	g							
Rhizoclonium			11					
Spyrogyra	11	g						
Staurastrum		9		2				
Tetrnedron						2	10	
Tetraspora	3							
Trochiscia		13		2				
Ulotrix	5	31		1		4		
Volvox		2						
Zygnema					50			
Bacillariophyceae								
Asteronella	11	8					3	
Achanthes		2						
Actinocyclus		2						
Centritmctus				2				
Cyclotella		2	20	1				
Cymbella		2						
Coscinodiscus								
Diatoma			20	2				
Eunotia			10	8			3	
Fragillaria				1				
Gomphonema								3
Meridion				2				
Melosira		2						
Navicula	16	4	3	2			3	1
Neidium			20					
Nitzschia	30							10

Table 4 (continued)

Surirella		13	20					27
Synedra		2	3					
Tabellaria	5	2	143	10			54	2418
Chrysophyceae								
Dynobrion							3	126
Dinophyceae								
Peridinium				2		24	3	5
Euglenophyceae								
Euglena			4	2				241
Phacus								32
Trachelomonas				2			3	284
Total Individual (ind/1)	163	418	759	75	273	610	17603	3264
Total genera	15	26	24	22	4	11	15	19

Table 5. Genera of phytoplankton observed in Lake Lutan

Group of taxa	Sampling time								
	Augst. 95	Sept. 96	Nov. 96	Jan. 97	Mar. 97	Apr. 97	May 97	Jun. 97	Oct. 97
Cyanophyceae									
Anabaena			29		64				
Aphanizomenon			7						
Aphanocapsa		27							493
Coelosphaerium		2							
Chroococcus							1		
Hapalosiphon			22						
Lyngbya			2						
Merismopedia							1		
Microcaete		12							
Microcystis			29			2	1		
Nostoc							1		13
Nodularia			2						
Oscillatoria	3	10	30		4		5	1	15
Phormidium									
Polycystis	22								
Rivularia									6
Spirulina			11				1		
Sticosiphon						6	1		
Chlorophyccae									
Ankistrodesmus		8	2			2			40
Basicladia		13	15						
Chlamidomonas		2		13	4				
Chaetophora						3			
Cladophora		4	25		4			1	
Closterium	26	27	13	5	32	2	5	4	2
Coelastrum				3					
Cosmarium			19	15		3			6
Crucigejfia					4				3
Desmidium			2						
Dictyosphaerium									2
Genicularia	7								
Gloeocystis			30						
Gonatozygon	14	33	49						3
Hyalotheca					4		1		
Ichthyocercus			2						
Kirchneriella		2	2				1		2
Lagerhemia						7			
Mougeotia	18								
Microsterias		2							
Netrium	3								
Oocystis							1	56	6
Pediaslrum						3			
Penium								1	
Pleurotaenium			27			6			
Quadrigula				3					

Table 5. (continued)

Rhizoclonium			7						
Scenedesmus					4			1	2
Spondylosium							1	1	
Spyrogyra		4	21			6	7		
Staurastrum						4			12
Tetraedron					4	3	18	25	
Trochiscia			61	150				1	
Ulotrix			7		4				
Zygnema		3	2				4		
Bacillariophyceae									
Asteronella	27								
Achanthes								1	
Actinocyclus			7						
Centritractus					8		1		
Cymbella						7			
Diatoma				5	8	13			2
Eunotia		9			4	2	5	1	2
Fragillaria		4		5		3		9	
Frustulia									
Gow/j/zone/na			7			3			
Meridion					5				
Navicula	32	15		5	4	24	5	4	15
Neidium		14							
Nitzschia									2
Pinnularia						2			
Surirella						6			
Synedra	24	4		5	32	7	1		26
Tabellaria									16
Chrysophyceae									
Dynobrion									5
Dinophyceae									
Peridinium									2
Euglenophyceae									
Euglena		10	9	13	8	7	18	1	20
Phacus		2	2	225	4		5	9	687
Trachelomonas		11	7	73	64	2	22	1	32
Total Individual (ind/1)	176	218	325	489	98	259	110	94	9019
Total genera	10	22	29	19	23	22	22	16	25

Table 6. Genera of phytoplankton observed in Lake Takapan

Group of taxa	Sampling time								
	Aug. 95	Sept. 95	Oct. 96	Jan. 97	Mar. 97	Apr. 97	May 97	Jun. 97	Oct. 97
Cyanophyceae									
Anabaena			253		7	191			80
Aphanocapsa				10					
Aphanothece								4	
Chroococcus									22
Lyngbya							3	4	
Merismopedia									22
Microcode									
Microcystis					6				
Nostoc			15	7					22
Oscillatoria		7	11	4					
Phormidium									
Polycystis		4							
Spirulina		4							
Sticosiphon							4		
Chlorophyceae									
Aclinaslrum								4	55
Ankistrodesmus									41
Bambusina			3						
Cerasterias			10						
Characium				80					
Cladophora					32		3	14	19

Table 6 (continued)

Closterium	22		72	7	9	20		24	32
Cosmarium			3		5	4			41
Crucigenia				7	1				
Desmidium			3						218
Dactylococcus									8
Dictyosphaerium									180
Exentrosphaeria				10	2				
Gonatozygon	55	18	10		1	4			
Hyalotheca			3						
Kirchneriella						8		4	279
Oocystis					44		49		
Ophyocytium			2						
Pediastrum								4	
Penium								4	
Quadrigula				10					
Scenedesmus					1				728
Spirotaenia								4	
Spondylosium									76
Spyrogyra	22	77	20						54
Staurastrum			8						
Tetraedron						4			
Tetralanthas									5133
Trochiscia			13	167	3				
Ulothrix			15						
Zygnema	11		4					4	
Bacillariophyceae									
Centritractus								4	
Cymbella							7	4	9
Diatoma				10				4	22
Eunotia				10		4		4	22
Fragillaria						4	38		44
Gyrosigma		4							
Melosira							3		
Navicula	132	51	4			4	3		41
Nitzschia	99								
Pinnularia									2
Pleurosigma								4	
Rhizosolenia									9
Surirella			2						
Synedra				80					9
Stephanodiscus									
Tabellaria		18	12	67		16		4	371
Chrysophyceae									
Dynobrion									11845
Dinophyceae									
Glenodinium			3						
Peridinium									22
Euglenophyceae									
Euglena			5	10					38
Phacus									41
Trachelomonas				10					200
Total Individu (ind/l)	341	183	471	489	98	259	110	94	9019
Total genera	**6**	**8**	21	15	11	10	8	16	31

Table 7. Genera of phytoplankton observed in Lake Sembuluh.

Group	Sampling time								
	Oct. 95			Oct96			Oct. 97		
	TB	BM	PEL	TB	BM	PEL	TB	BM	PEL
Cyanophyceae									
Aphanocapsa						9			
Chroococcus							320	889	178
Merismopedia				2					
Microcystis	37	4							
Oscillatoria	33	4		3					
Polycystis		4							
Spirulina			2						
Chlorophyceae									
Actinastrum							27		
Ankistrodesmus				5	4	3			
Arthrodesmus							9400	25066	38844
Characium						1			
Closterium	7			11	4	11	560	1200	1556
Caelastrum							27		
Cosmarium				10	9	7	293	800	267
Crucigenia				3					
Desmidium					1			45	
Dermatophyton									
Dictyosphaerium				3	1		480	800	756
Dimorphococus							213	4020	267
Euastrum							27		
Gonatozygon	15	15							
Kirchneriella							80	4913	267
Lagerhemia							53	178	
Meugotia		4	33						
Oocystis							107		
Richtrella		15							
Scenedesmus					1	4			89
Sphaerocystis					1				
Spondylosium							107	89	
Spyrogyra	70	84	22				213		178
Staurastrum				78	34	77	1227		1156
Tetraspora		7							
Ulothrix				3			187	466	
Xanthidium							27		
Bacillariophyceae									
Amphiphora								466	
Cymbella				5					
Diatoma		4		13	1				
Eunotia				2	5				
Fragillaria								45	
Meridion				2					
Melosira				2					
Navicula		11		78	1		27	45	
Nitzschla	58	77	2						
Rhizosolenia				78		4			
Surirella				2			27	89	
Synedra				2	1		293	45	
Tabellaria				135	127		133	267	
Chrysophyceae									
Dynobrion							27		
Dinophyceae									
Peridinium				8	6	2	27		
Euglenophyceae									
Euglena							27	113	
Phacus									
Trachelomonas				3					
Total Individu (ind/1)	220	229	59	443	196	109	10508	39536	16392
Total genera	6	11	4	21	14	9	25	19	20

TB : Gulf of Telaga Bintang; BM: Gulf of Batu Menangis; PEL: Pelagic habitat of Lake Sembuluh

Table 8. Average density of phytoplankton according to the group of taxa in Lake Rengas, Lutan, Takapan and Lake Sembuluh.

Sampling Sites	Cyano-phyceae	Chloro-phyceae	Bacillario-phyceae	Chryso-phyceae	Dino-phyceae	Eugleno-phyceae	Total average
L. Rengas, Lutan & L. Takapan							
August 95	11	90	125	0	0	2	234
September 95	15	95	73	0	0	6	189
September 96	51	116	18	0	0	5	193
October 96	92	32	28	0	3	0	152
November 96	90	245	27	0	0	8	370
January 97	18	321	142	0	0	0	481
March 97	15	57	31	0	0	1	104
April 97	66	124	31	0	0	0	221
May 97	14	217	21	0	0	0	252
June 97	4	3891	36	0	0	0	3931
October 97	226	2348	1017	437	11	929	4968
L. Sembuluh							
October 95	28	91	50	0	0	0	169
October 96	2	90	64	89	5	0	250
October 97	462	20917	456	456	9	47	22137

Table 9. Diversity index and genera number of phytoplankton in Lake Rengas, Lake Lutan, Lake Takapan and Lake Sembuluh.

Date	Lake Rengas		Lake Lutan		Lake Takapan		Lake Sembuluh					
							Tti		BM		PEL	
	H"	n	H"	n	H"	n	H"	n	H"	n	H"	n
Ags 95	4.33	15	2.42	10	1.41	6						
Sep95	-		-	-	1.61	8						
Oct 95	-		-	-	-	-	1.52	6	1.55	11	0.71	4
Sep 96	-		4.02	22	-	-						
Oct 96	-		-	-	2.67	21	2.38	21	1.80	14	2.22	9
Nov96	3.11	26	5.03	29	-	-						
Jan 97	3.15	24	1.83	13	2.52	15						
Mar 97	3.86	22	3.54	19	1.96	11						
Apr.97	0.96	4	4.01	19	2.03	10						
May.97	1.95	11	3.47	23	1.44	8						
Jun.97	0.75	15	2.13	22	3.38	16						
Oct.97	2.13	16	2.05	16	3.09	31	3.03	25	2.23	19	2.79	20
Average	2.52	17	3.17	20	2.23	14	1.26	17	2.13	15	2.68	17