Water Quality and Photosynthetic Activity of Tombo-ike

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Introduction

In 1982, we observed the water quality of the three ponds of Tombo-ike where is situated at the Kita-hasen of the Kiso-gawa River. The observation was carried out to clarify how these ponds have been varied for the change of the environment since 1976. We determined the primary production in these ponds to observe the eutrophication during the stagnation and the circulation periods.

Method

The observation was carried out on July 16 and November 6, 1982. In Fig. 1, the locations of the three ponds and the sampling stations (St. 1-A, St. 1-B, St. 2 and St. 3) were shown. The water samples were collected respectively from the surfaces and the bottoms by a vinyl tube and a hand-pump. For nutrient analyses and chlorophyll-a measurement, the water samples were filtered immediately through Whatman GF/C glass-fiber filters. Dissolved oxygen was measured by DO meter (YSI Co.). Ammonia was determined by the method of Sagi (1966), nitrite by Bendschneider & Robinson (1952), nitrate by Wood et al. (1967), phosphate by Murphy & Riley (1962) and dissolved organic phosphorus by Menzel & Corwin (1965). Chlorophyll-a was measured by the fluorometric method of Holm-Hansen et al. (1965). The residual water samples were filtered through 25 μm mesh screen, and these collected samples were used for the microscopic observation. Net production was measured by the oxygen method under the light-saturated condition.

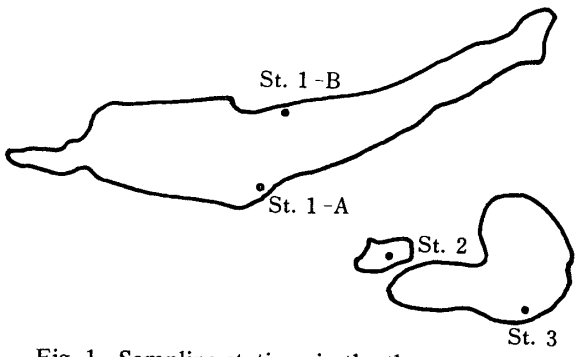

Fig. 1 Sampling stations in the three ponds of Tombo-ike.

Result and Discussion

1. General feature

The values of water temperature in July, 1982, were about 7°C lower than those in 1976. Dissolved oxygen concentrations in the surface were super-saturated at St. 1-A and St. 1-B. The high value of chlorophyll-a (11.1 $\mu g \cdot l^{-1}$) was obtained in the surface at St. 1-B, but low (4.2 $\mu g \cdot l^{-1}$) in the surface at St. 1-A. At St. 1-A, the low value was obtained in the surface, though remarkable high chlorophyll-a value (17.6 $\mu g \cdot l^{-1}$) was found in the bottom. At every stations, the values of chlorophyll-a were lower in the surface than those in the bottom

because of the accumulation of vigorous phytoplankton near the bottom.

In November, dissolved oxygen concentrations in the surface were almost the same as those in the bottom on account of water circulation at all the stations. The low values of dissolved oxygen were observed 51% at St. 1-A, 79% at St. 1-B, 51% at St. 2 and 60% at St. 3. These suggests that photosynthesis was not active in every pond at that time.

2. Nutrient

In July, NO_2-N, NO_3-N and NH_4-N concentrations showed generally low values, especially NO_3-N were very low, while DON showed very high values. PO_4-P concentrations in the surface were lower than those in the bottom. These results suggest the utilization by phytoplankton is associated with photosynthesis. Although dissolved oxygen concentrations were very low in the bottom, NH_4-N and PO_4-P concentrations were not so high. In general, NH_4-N and PO_4-P are released from the bottom sediment under the reduced condition, but it dose not seem to occur in these three ponds. Therefore, in these ponds, the release of those compounds is extremely little or the consumption of those compounds by phytoplankton are much. The values of phosphate did not show remarkable seasonal change, but dissolved organic phosphorus showed higher values in November than those in July. From the observations in July and November, there were no marked differences between nutrients concentrations in the surface and those in the bottom.

3. Vertical distribution of dissolved oxygen

Vertical distributions of dissolved oxygen in the three ponds in July were shown in Fig. 2. At St. 1-A, dissolved oxygen concentration in the surface exceeds the saturation value, but it decreases suddenly between 0.5m and 0.75m in depth, and it was anoxic in the bottom. At St. 3, however, 3.0 mg $O_2 \cdot l^{-1}$ was observed in the bottom. The bottom sediment of St. 1 showed black color, while St. 3 did brown color. It can be surmised that the artificial pond

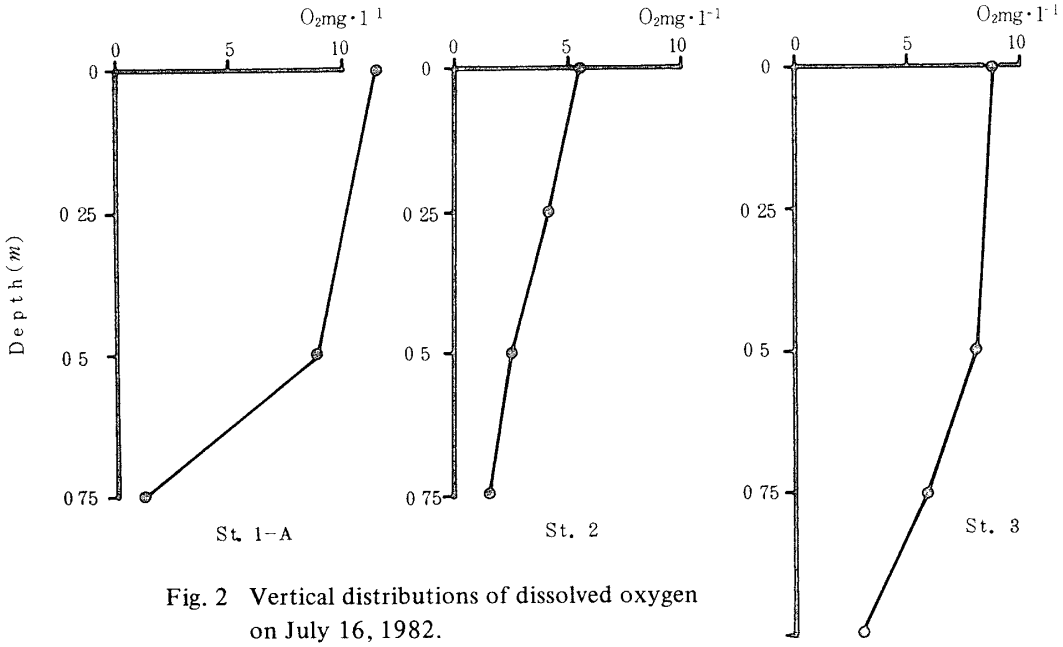

Fig. 2 Vertical distributions of dissolved oxygen on July 16, 1982.

of St. 3 is not so eutrophic as St. 1. At St. 2, the values of dissolved oxygen were 5.7 $mgO_2 \cdot l^{-1}$ (62%) and 1.4 $mgO_2 \cdot l^{-1}$ (15%) in the surface and the bottom respectively. Then, St. 2 seems to be as eutrophic as St. 1.

4. Comparison of the components of water quality in 1976 with those in 1982

Table 1. Comparison of the components of water quality in 1976 with those in 1982.

		NH_4-N	NO_2-N	NO_3-N	T.in.N ($mg \cdot l^{-1}$)	PO_4-P	DOP	TSP	DO (%)	Chl.a ($\mu g \cdot l^{-1}$)
JUL. 1 − 0 m	'76	.061	.004	.157	.222	.011	.005	.016	40.3	(6.2)
	'82	.015	.001	.038	.020	.013	.007	.020	137.0	4.2
	'76	.050	.003	.162	.215	.010	.010	.020	35.9	6.2
+ B	'82	.023	.002	.028	.040	.006	.005	.010	10.8	17.6
2 − 0 m	'76	.053	.003	.158	.214	.007	.003	.010	55.2	1.6
	'82	.009	.001	.003	.014	.003	.006	.009	62.1	11.6
− + B	'76	.066	.003	.192	.261	.009	.004	.013	28.7	12.4
	'82	.033	.001	.003	.037	.007	.001	.008	15.2	12.1
3 − 0 m	'76	.070	.003	.212	.285	.007	.003	010	38.6	2.3
	'82	.012	.00	.003	.016	.005	.002	.007	95.1	6.6
− + B	'76	.040	.003	.196	.243	.006	.004	.010	22.4	1.7
	'82	.015	.002	.002	.019	.005	.001	.006	34.2	14.2
NOV. 1 − 0 m	'76	.004	.001	.076	.122	.007	.008	.015	68.9	4 8
	'82	.021	.004	.011	.035	.006	.012	.018	50.6	15.8
− + B	'76	.006	.002	.015	.083	.006	.008	.014	64.0	6.2
	'82	.020	.003	.017	.040	.008	.014	.022	46.2	10.5
2 − 0 m	'76	.007	.001	.032	.040	.006	.007	.013	61.2	1.1
	'82	.026	.004	.016	.046	.003	.011	.014	51.1	9.7
− + B	'76	.013	.003	.035	.051	.005	.007	.012	51.6	1.2
	'82	−	−	−	−	−	−	−	−	−
3 − 0 m	'76	.014	.002	.025	.043	.009	.008	.017	47.6	1.7
	'82	.066	.003	.016	.085	.003	.012	.015	60.4	2.5
− + B	'76	.014	.004	.024	.042	.007	.006	.013	46.1	2.2
	'82	.070	.003	.028	.101	.004	.00	.304	45.1	19.7

At St. 1 and St. 2, the values of dissolved oxygen in July, 1982 were higher in the surface and lower in the bottom than those in 1976. This can be surmised that photosynthesis is active at St. 1 and St. 2 in 1982, and the eutrophication is progressing in these two ponds. At St. 3, dissolved oxygen concentration in the surface is low, 39%, in 1976 and high, 95%, in 1982. These results seem to suggest that the primary production has been increasing in this artificial pond. The values of chlorophyll-a were much higher in 1982 than those in 1976 at all stations, giving, for instance, three times higher in the surface and ten times in the bottom at St. 3.

NH_4-N, NO_2-N and NO_3-N concentrations in 1982 were lower than those in 1976 both in the surface and in the bottom. Then, the total inorganic nitrogen concentrations in 1982 were rather lower than those in 1976, giving 1/10 in the surface and 1/5 in the buttom at St. 1, 1/20 and 1/9 at St. 2 and 1/30 and 1/25 at St. 3. These results seem to suggest that the consumption of nutrients by phytoplankton is active in 1982.

5. Photosynthetic activity

As shown in Table 2, the high value of net production, 3.0 $mgO_2 \cdot l^{-1} \cdot hr.^{-1}$, was obtained

in the bottom at St. 1-A where high chlorophyll-a amount was measured. In the surface, however, 0.1 $mgO_2 \cdot 1^{-1} \cdot hr.^{-1}$ was obtained. Net production values of St. 2 were similar to those of St. 1-B. At St. 3, the value of net production was higher in the bottom than that in the surface as shown at the other stations, but the value in the bottom was rather lower than those of the other stations. Then, net production and chlorophyll-a values were higher in the bottom at all stations. It could be explained by the existence of active phytoplankton in the bottom. From the microscopic observation, filamentous green alga, *Spirogyra* sp., was dominant species at St. 1 and St. 2, while diatoms were dominant at St. 3. The value of photosynthetic activity of *Spirogyra* which covered the water plants at St. 1-A in July was 10.3. This value is similar to the values which are measured on phytoplankton in the eutrophic lakes. At St. 3, chlorophyll-a concentrations were low in November and net production values were also lower than those of the other stations. From a view of the measurements of water quality, the eutrophication has been proceeding at St. 3 as like as the other two stations during past 6 years. The water plants have been growing in St. 1 and St. 2. The open space was not recognized at St. 2 which was covered by the water plants in November.

Table 2. Chlorophyll-a and net production in the three ponds of Tombo-ike.

	Chl.a	Pn
JUL.		
1 −A− 0 m	4.2	0.14
−+B	17.6	3.00
−B− 0 m	11.1	0.16
2 − 0 m	11 6	0 21
+B	12.1	1 06
3 − 0 m	6 6	0.16
+B	14.2	0.76
1 −A ·	1.11	11.40
1 −B ·	0.26	0.43
NOV.		
1 −A− 0 m	15.8	0 27
+B	10.5	0 22
−B− 0 m	19.1	0.16
2 − 0 m	9.7	0 32
3 − 0 m	2 5	0 10
1 −B ·	0.29	3.00

Chl.a : $\mu g \cdot 1^{-1}$
Pn : $mg\,O_2 \cdot 1^{-1}$
Spirogyra Colony ($100cm^2$)

From the results of this study we presumed that these three ponds may change more eutrophic state.

Acknowledgment

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References

1) Bendschneider, K. and R.J. Robinson: J. Mar. Res., **11**, 87-96 (1952)
2) Menzel, D.W. and N. Corwin: Limnol. Oceanogr., **10**, 280-282 (1965)
3) Murphy, J. and G.A. Riley: Anal. Chim. Acta, **27**, 31-36 (1962)
4) Sagi, T.: Oceanogr. Mag., **18**, 43-51 (1966)
5) SCOR-UNESCO Working Group 17: UNESCO, 69 pp. (1964)
6) Wood, E.D. et al.: J. Mar. biol. Ass. U.K., **47**, 23-31 (1967)
7) Yagi, A.: Biological Resources of the Tombo-ike, the Kita-hasen of the Kiso-gawa River, (in Japanese), 1-12 (1908)
8) Yagi, A. and N. Ishida: Environmental Resources of the Tombo-ike (Kiso-gawa River), (in Japanese), 1-15 (1983)

要　　約

1975年から1976年にかけて環境調査を実施した木曽川北派川トンボ池で3つの池において，その後の5年間に池及び周辺環境の変化等に伴ない，水質，藻類にどのような変動が認められるかの観測を1981年に行なった．

在来の2つの池（st.1とst.2）では，底層で1976年の調査時よりも還元状態が進行し，富栄養化は一段と進行していることが認められた．

造成地（st.3）では，溶存酸素が底層でも，他の池に比べて2倍程度存在し，富栄養化はまだ顕著ではなかった．

3つの池ともに，クロロフイル－a量は，底層で表層に比べ，ほぼ2倍の値を示し，かつ純光合成量も高かった．

成層期の7月における栄養塩の中で，窒素は1976年の方が多く存在していることが認められたが，循環期の10月には差はほとんどなかった．

3つの池ともに，ヨシなどの抽水植物群落及びクロモなどの沈水植物群落が繁殖し，これらの生産力が高いことはすでに指摘されているので，これらが池内の生産，栄養塩類の循環に対する寄与については今後検討されなければならない課題である．