Eutrophication Mechanisms of Coastal Seas in Yamaguchi Prefecture

KATSUMASA TANAKA, YUKIYA IMATOMI, KAZUMASA SAEKI, SEIJI FURUTANI, KAZUHIKO TORII and HIROSHI MATSUMURA
Yamaguchi Prefectural Research Institute of Health, 535, Asada, Yamaguchi, 753 Japan

An investigation was made of the two different types of semi-closed, organically polluted bays in the northern part of the Sea of Suo, the Seto Inland Sea. One is Tokuyama bay that is surrounded by industrial complexes, the other is Yamaguchi bay that seems to be affected mainly by the household effluent through many rivers. As for Tokuyama bay, little sea water exchange was observed. During the summer period, vertical mixing was weak owing to thermal stratification. Dissolved oxygen concentration was low in the lower layer. And also, the primary production was active throughout the year. In Yamaguchi bay, the exchange rate of sea water was relatively high and the contribution of primary production to the organic pollution in the bay was small. It was found that the pollutant load by domestic sewage had a great influence on the sea water quality.

1. Introduction

Eutrophication in semi-closed sea areas such as estuaries and bays increases productivity of phytoplankton and causes red tide outbreaks. Water pollution by phytoplankton makes the bottom layer oxygen deficient, destroys scenery and sometimes decreases the catch of fish. Water pollution in some sea areas of Yamaguchi Prefecture is still serious problem. Environmental water quality standard have not been fully attained yet. In order to clarify the eutrophication mechanisms, two different types of bays were investigated hydrographically and biochemically and compared each other.

2. General Conditions of the Two Bays

A. Yamaguchi bay
Area; $1.8\times10^{7}m^{2}$, Capacity; $6.3\times10^{7}m^{3}$
Surroundings; Agricultural Lands and Residential Sections
Amount of Influent River Water; Much
the Number of Sampling Points; 7

B. Tokuyama bay
Area; $4.7\times10^{7}m^{2}$, Capacity; $5.7\times10^{8}m^{3}$
Surroundings; Industrial Complexes and Streets
Amount of Influent River Water; Little
the Number of Sampling Points; 6

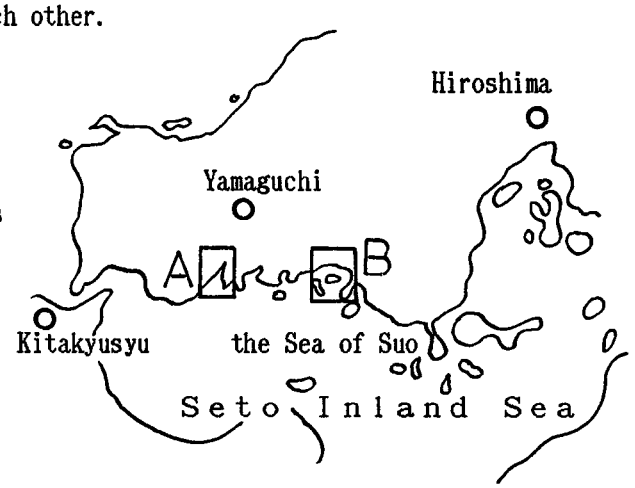

Fig. 1, Locations of the Two Bays

3. Methods

Samples were collected using Van Dorn water sampler. Samples for determination of dissolved organic carbon (DOC) were filtered through by glass fiber filter preignited at 450℃. The amount of primary productions was calculated from the change of dissolved oxygen (DO). Analytical methods are shown in Table 1.

Marine Pollution Bulletin, Vol. 23, pp. 665-667, 1991.
Printed in Great Britain
0025-326X/91 $3.00+0.00

Table 1, Analytical Methods

TOC, DOC	Menzel-Vaccaro Method
chlorophyll-a, SiO_2-Si	Strickland-Parsons Method
T-N, NO_3-N	Wood, Armstrong-Richards Method
NH_4-N	Solorzano Method
T-P	Murphy-Riley Method

4. Results and Discussion

Results of sea water analysis of the two bays are shown in Table 2. The concentrations of all items were higher in Tokuyama bay than in Yamaguchi bay. Considering the differences of chlorophyll-a concentrations between the two bays, differences of TOC values are so small. Besides, the fresh water bacteria and coliform group were found in fairly large quantities. These results indicated that primary production in Tokuyama bay was relatively active and that Yamaguchi bay seemed to be affected mainly by household effluent through many rivers. [1) 2)]

Table 2, Results of sea water analysis of the two bays

A:Yamaguchi bay B:Tokuyama bay			chl-a (ug/l)	TOC (mg/l)	DOC (mg/l)	T-N (mg-1)	NH_4-N (mg/l)	NO_3-N (mg/l)	T-P (mg/l)	SiO_2Si (mg/l)
A	summer	maximum	16.7	3.0	1.8	0.559	0.075	0.036	0.067	1.06
		mean	3.0	1.8	1.4	0.322	0.007	0.007	0.023	0.40
	winter	maximum	12.5	2.6	2.0	0.453	0.074	0.026	0.054	0.65
		mean	2.7	1.6	1.3	0.230	0.012	0.007	0.024	0.19
B	summer	maximum	36.9	4.3	2.4	0.809	0.256	0.163	0.240	1.58
		mean	7.6	2.3	1.5	0.420	0.029	0.021	0.037	0.51
	winter	maximum	21.0	2.8	2.0	0.699	0.133	0.221	0.041	0.76
		mean	9.4	1.9	1.3	0.401	0.030	0.061	0.031	0.29

Nitrogen, phosphorus and carbon contents of phytoplankton origin of the two bays are shown in Table 3. These were calculated by Tezuka and others report[3)] and R.K.R. Model[4)]. The proportions of particulate N.P.C of phytoplankton origin in Tokuyama bay were considerably larger than those in Yamaguchi bay.

Table 3, Nitrogen, phosphorus and carbon contents of phytoplankton origin

		Pl-C (mg/l)	Pl-C/POC (%)	Pl-N (mg/l)	Pl-N/PN (%)	Pl-P (mg/l)	Pl-P/PP (%)
Yamaguchi bay	summer	0.150	37.5	0.023	28.8	0.0014	11.7
	winter	0.135	45.0	0.020	45.5	0.0013	16.3
Tokuyama bay	summer	0.380	47.5	0.058	49.2	0.0036	15.7
	winter	0.470	78.3	0.071	52.6	0.0044	23.2

The amounts of primary productions calculated from the change of dissolved oxygen[5) 6)] are shown in Table 4. In Yamaguchi bay, there was little likelihood of active photosynthesis even in summer. On the other hand, the primary production in Tokuyama bay was active throughout the year.

Table 4, Comparison of the amounts of primary productions ($gC/m^2/day$)

Yamaguchi bay	April～May	June ～July	August ～September	October～November	December～January	February～March
	-0.40	-0.30	0.82	0.31	-0.15	0.02

Tokuyama bay	spring	summer	autumn	winter
	2.25	2.70	0.19	0.87

Comparison of organic pollutant load to the two bays are shown in Table 5. In Yamaguchi bay, organic pollutant(as TOC) attributable to influx was estimated to be 70% and over of the total pollutant load, the contribution of primary production to the organic pollution was small. In Tokuyama bay, primary production was very active and 93% of organic pollutant (as TOC) was attributed to the photosynthesis.

Table 5, Comparison of organic pollutant load to the two bays (%)

	primary production	influx
Yamaguchi bay	27	73
Tokuyama bay	93	7

4. Conclusion

(1) In Yamaguchi bay, organic pollutant(as TOC) attributable to primary production was estimated to be 27% of the total pollutant load. The proportions of particulate N, P, C, other than that of phytoplankton origin, were relatively large, the fresh water bacteria and coliform group were found in fairly large quantities.

(2) In Tokuyama bay, the proportions of particulate N. P. C. of phytoplankton origin were large. Primary production was very active and 93% of organic pollutant(as TOC) was attributed to the photosynthesis.

(3) It is obvious from these results that Yamaguchi bay is greatly influenced by the river water and that it is important to treat household sewage satisfactorily.
In order to reduce water pollution and red tide occurrence in Tokuyama bay, it is suggested that the sea water exchange rate should be improved and that the bottom sediment should be dredged.

References

1) K. Saeki and others: Annual Report of Yamaguchi Prefectural Environmental Pollution Research Center, 8, 51～67 (1982)
2) K. Saeki and others: ibid. 12, 49～54 (1986)
3) Y. Tezuka and others: Report of the Co-operative Research Ministry of Education, Science and Culture 21 (1974)
4) Redfield, Ketchum and Richards: The influence of organisms on the composition of sea water. In: The sea, 2, 26～77 (1963)
5) K. Tanaka and others: Annual Report of Yamaguchi Prefectural environmental Pollution Research Center, 13, 26～28 (1987)
6) S. Furutani and others: ibid. 7, 84～88 (1981)